US Army Corps
of Engineers
Construction Engineering
Research Laboratories

USACERL Technical Report 96/15
December 1995

Historic Preservation Plan for St. Johns River Lighthouse, Naval Station Mayport, Florida

by

Don K. Kermath
Samuel L. Hunter
Donald R. Uzarski
Frederick J. Rushlow
Michael Vogel
Eleanor L. Esser

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave Blank)*

2. REPORT DATE
December 1995

3. REPORT TYPE AND DATES COVERED
Final

4. TITLE AND SUBTITLE
Historic Preservation Plan for St. Johns River Lighthouse, Naval Station Mayport, Florida

5. FUNDING NUMBERS
MIPR
E87930097
26 February 1993

6. AUTHOR(S)
Don K. Kermath, Samuel L. Hunter, Donald R. Uzarski, Frederick J. Rushlow, Michael Vogel, and Eleanor L. Esser

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Construction Engineering Research Laboratories (USACERL)
PO Box 9005
Champaign, IL 61826-9005

8. PERFORMING ORGANIZATION REPORT NUMBER
TR 96/15

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Corps of Engineers Mobile District
PO Box 2288
Mobile, AL 36628-0001

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

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14. SUBJECT TERMS
St. Johns River Lighthouse
historic buildings—conservation and restoration
National Historic Preservation Act

15. NUMBER OF PAGES
98

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std 239-18
298-102

Foreword

This study was conducted for the U.S. Army Corps of Engineers Mobile District under Military Interdepartmental Purchase Request (MIPR) No. E87930097, dated 26 February 1993. The technical monitor was Ernest Seckinger, CESAM-PD-ER.

The work was performed by the Maintenance Management and Preservation Division (FL-P) of the Facilities Technology Laboratory (FL), U.S. Army Construction Engineering Research Laboratories (USACERL). The survey team gratefully acknowledges the assistance provided by the personnel of the Naval Station Mayport. Simon S. Kim is Chief, CECER-FL-P, Donald F. Fournier, Jr. is Acting Operations Chief, and Alvin Smith is Acting Chief, CECER-FL. The USACERL technical editor was William J. Wolfe, Technical Resources Center.

COL James T. Scott is Commander and Acting Director of USACERL, and Dr. Michael J. O'Connor is Technical Director.

Tri-Services Cultural Resources Research Center

The Tri-Services Cultural Resources Research Center is a research and technical support center that assists the U.S. military services in the stewardship of cultural resources located within Department of Defense (DOD) installations or facilities. The Center, located at USACERL, helps installations manage their cultural resources and comply with Federal, State, and DOD preservation mandates.

Contents

1 Introduction

Background

St. Johns River Lighthouse is located on Naval Station Mayport in northeastern Florida, north of St. Augustine. As early as 1562, the explorer Jean Ribault recognized the safe harbor this inlet allowed when he landed near the site and placed a monument of his landing. The site's strategic location at the mouth of the St. John River made it historically significant to shipping and boat traffic as a protected entry from the Atlantic Ocean to the inland river system.

The river's well-known use for shipping spurred Congress to appropriate $6,500 for the construction of a lighthouse at the mouth of the St. John River on 23 May 1828. The project was completed by 1830, but unfortunately, its proximity to the water and later changes in topography combined to damage the lighthouse. This first lighthouse was then destroyed to prevent injuries or further damage.

On 30 June 1834, Congress appropriated $10,500 to rebuild the lighthouse. The relocated site was 1.6 miles upriver from the previous lighthouse. Vintage photographs show this lighthouse to be of a simple brick design. The lighthouse functioned into the 1850s. In 1852, $10,000 was appropriated for bank stabilization. Unfortunately, the river continued to erode the site, wearing away the land and obscuring the light with rising sand dunes.

In 1854, Congress appropriated $15,000 to build a taller lighthouse further inland, across the sand bar from the old tower. By 1859 a third lighthouse was completed. The structure was an 85-ft, red-brown brick tower. The entry to the building was constructed through a small adjoining building on the west side. The second lighthouse was left standing, though in ruins.

During the Civil War, the light functioned as a channel marker for Union boats, a use curtailed by the Confederates, who extinguished the light during the conflict. After the war, lanterns were substituted for the tower lamp until the light could be replaced in 1867.

In 1887, an overhaul of the lighthouse was planned to make the tower 12 ft taller and to install a new copper dome. (Congress had considered building a modern lighthouse on Fort George Island in 1889 instead, but never acted on the proposal.) A new copper dome was installed, but the tower was not raised in height. An 1887 drawing also shows brick corbelling below the third story, which is not seen in an 1854 drawing.

The last improvement before the building closed was an increase in the light's candlepower by 15x in 1912. In 1929, the lighthouse was rendered obsolete by the St. Johns lightship, anchored 8 miles offshore—manned by the Coast Guard until 1954 when it was replaced by the current lighthouse on the east side of Naval Station Mayport.

After the lighthouse was closed, Naval Station Mayport grew around it, including construction of a nearby airfield. This construction raised the elevation of the original grade an estimated 9 to 12 ft, closing off the original tower entrance and requiring that entry be made through a window. By that time, the attached outbuilding had been removed and many of the tower's windows were broken or missing.

The National Historic Preservation Act of 1966 requires federal agencies to minimize harm to properties eligible for the National Register of Historic Places. In accordance with this law, two restorations of the tower were undertaken in the 1980s. Windows were replaced and the exterior was stabilized, including repair and reconstruction of the original copper light. An attempt was also made to correct moisture problems in the lighthouse. This restoration greatly improved the structure's condition, and with planned maintenance, this historically important site can be preserved in its present excellent condition.

Objectives

The general purpose of the research was to develop a preservation plan for base engineers and cultural resource personnel to maintain the St. Johns River Lighthouse in accordance with laws and regulations so that this cultural resource may someday be put back into productive use. Specific objectives were to:

1. Identify component and system failures and causes of those failures
2. Develop a layaway plan to cost-effectively preserve this cultural resource
3. Provide a reference document to help base engineers and cultural resource personnel maintain the lighthouse during the layaway period.

Approach

A survey team, consisting of two civil engineers and an architect, from the U.S. Army Construction Engineering Research Laboratories (USACERL), traveled to the Naval Station Mayport 14 September 1993. A literature search was conducted into topics of lighthouse maintenance, construction, and general history. Historic, inspection, and condition assessment information were gathered and compiled into a preservation plan for the historic St. Johns River Lighthouse.

Scope

The information in this report is intended to assist in developing contract documents for construction work. This report contains no information that can be used "as is" for contract documents for construction work.

Relevant Laws and References

National Historic Preservation Act of 1966, as amended, PL 89-665.

The Secretary of the Interior's Standards for the Treatment of Historic Properties 1992 (text included in Appendix A to this report).

Historic Structures Preservation Manual NAVFAC MO-913 (Naval Facilities Engineering Command, September 1990).

Metric Conversion Factors

U.S. standard units of measure are used throughout this report. A table of metric conversion factors is presented below.

1 in.	=	25.4 mm
1 ft	=	0.305 m
1 mi	=	1.61 km

2 Historic Structure Report

Introduction

An historic structure report is set up to identify two conditions:

- The physical condition of the structure
- The historic integrity condition of the resource.

The physical condition assessment identifies the various building systems and the failures of components within these systems. Additionally, the probable cause of the failures are identified so the maintenance work can address reasons for failure and prevent them from recurring. The assessment refers to recent restorations done to the structure (Appendix B) and to sample specifications (Appendix C).

Physical Condition Assessment

Condition Assessment Procedure

The condition assessment procedure consists of four parts: (1) dividing the building into logical systems and components, (2) visually inspecting the systems and components, (3) evaluating their existing state, and (4) compiling the findings into an overall rating.

Building Division. The lighthouse consists of five building systems: (1) site, (2) exterior circulation, (3) exterior closure, (4) interior construction, and (5) electrical. Each system contains applicable components (described in more detail in Chapter 4 of this report).

Inspection. The team visually inspected each system and component and recorded the degree and type of all distresses discovered.

System Condition Assessment. The team assessed component or system condition by considering distress amount, its influence on component or system functionality, and required maintenance and repair (M&R) to correct the distress (Table 1).

Building (Lighthouse) Condition Assessment. Combining the results from each system, the team obtained a composite lighthouse condition.

Condition Assessment

Building and Systems Description

The structure is located in the northwest corner of the U.S. Naval Station, Mayport, FL, in a location visible from both the station airport and the town of Mayport. The lighthouse has four levels and is noteworthy for its massive masonry construction: (1) grade, (2) a three-quarter interior platform at the same level of the first course of corbelled brick, (3) a slate balcony and interior platform, and (4) the cast-iron balcony and platform where the light was located. A helical stair connects the first and second levels, and metal ladders connect the other levels. The original entry was on grade from the west side through a small building attached to the side of the lighthouse. This building is now gone; the original door is bricked in and buried in 7 ft of fill. Entry is now gained by ladder through a north window, 8 ft above the existing grade.

Site System: Condition Rating 5

Components. The site system consists of those components commonly associated with the lighthouse, but not attached to the exterior, i.e., the landscape and drainage (Figure 1). The site is unusual due to the increase in elevation around the lighthouse

Table 1. Condition assessment scale.

Rating	Condition	Definition
6	Excellent	Minimal deterioration, only preventive or minor maintenance required
5	Very Good	Minor deterioration, preventive maintenance or minor repair required
4	Good	Moderate deterioration, moderate maintenance of minor repair needed
3	Fair	Significant deterioration, significant maintenance of moderate repair needed
2	Poor	Severe deterioration over a small portion, major repair needed
1	Very Poor	Severe deterioration over a moderate portion, requiring major repair but less than total restoration
0	Failed	Severe deterioration over a large portion, total restoration required

that covered the previously exposed base of the lighthouse. This changed the original conditions at the base of the lighthouse; some of the structure's distresses result from this change in grade.

Assessment. The site system is in very good condition. Inspection shows that:

- The landscaping around the lighthouse is well maintained.
- Slight water drainage around the lighthouse is evidenced by damp interior brick below grade.

Probable cause. The ground does not slope away from the lighthouse. likely a result of improper grading during the recent restoration.

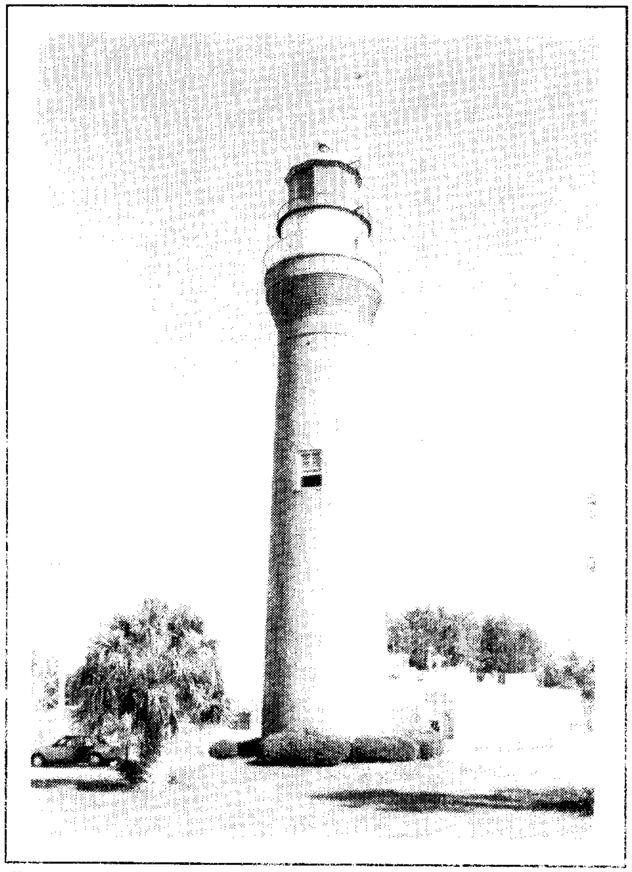

Figure 1. St. Johns River Lighthouse site.

Solutions.

1. Cut and grade the land to properly slope away from the lighthouse and reduce drainage problems.
2. If determined to be economically feasible, cut back the fill and install a retaining wall about 40 ft from the lighthouse to restore the original entry and site elevation. A French drain could also be installed around the base to intercept drainage. Note that the area should first be surveyed to avoid conflicts with underground construction (e.g., sanitary lines). Note that, if properly ventilated, the building can be maintained in good condition without excavation.

Masonry System: Condition Rating 4

Components. The masonry system consists of reddish-brown, 3 x 4 x 9-in. common brick, similar to those used at Fort Clinch from 1851 to 1862 (Figure 2). The texture of the mortar indicates that it was a manufactured lime or natural cement. (The exact composition could be determined with a laboratory test.) The masonry tapers from a 15-ft outside diameter of the base to a 10-ft, 8-in. diameter below the corbelled projection at the top. The walls appear to be numerous brick-widths thick, measuring 42 in. at the north window/entry. The interior systems is composed of the interior face brick of the wall. This brick is the same as the exterior face brick. The exterior of the tower is painted reddish and the third level brick walls are stuccoed over and painted white.

Figure 2. Detail of masonry.

Assessment. The masonry system is in good condition. Appendix C and Prudon (19[illegible]) elaborate on specifications and restoration (Figure 3). Inspection findings are as follows:

1. Small amounts of cracked and missing mortar were noted where the small building (now demolished) had joined the lighthouse.

   Probable cause. The soft mortar is unprotected from the weather.

   Solution. Repoint with a soft lime-based mortar in these areas to prevent further deterioration.

2. Small areas of stucco have delaminated in various locations around the lighthouse.

   Probable cause. Age of the stucco.

3. There is some peeling paint on the brick just below the platform on the south side of the lighthouse.

   Probable cause. Age of the paint and exposure to sun.

4. The brick walls show very little signs of deterioration except below grade where the brick is damp.

   Probable cause. Improper drainage from the ground around the building's base retains moisture.

   Solution. See solution for site problem (p 10).

Circulation System: Condition Rating 4

Components. The circulation system consists of interior and exterior stairs, interior and exterior platforms and entries into each level. The interior circulation consists of a radial staircase (each 16 steps forming a full circle), with landings opposite each window.

Class of Crack	(A) Crack Size in mm.	(B) Physical Maximum Width in mm. (Full Scale)
P 0	Less than 0.1	0.1
P 1	0.1 to 0.3	0.3
P 2	0.3 to 1.0	1.0
P 3	1.0 to 2.0	2.0
P 4	2.0 to 5.0	5.0
P 5	5.0 to 15.0	15.0
P 6	15.0 to 25.0	25.0
P 7	Greater than 25.0	> 25.0

A) Crack size is to be assessed in direction of movement.
B) Crack width is shortest distance between edges.

A = Crack Size
B = Crack Width
A = B When there is no displacement along the line of the crack, that is, there is tensile failure but no shear movement.

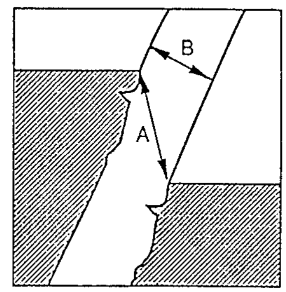

Figure 3. Pynford classification of visible damage to walls.

Stair and support height is 8 in. (Figure 4). The treads and the average riser are composed of 4-1/2-in. thick, grey-green slate forms. The stair is supported by a the exterior brick walls and a cylindrical brick column that rises through the middle of the shaft. These stairs lead to a slate-covered balcony that caps the corbelled top of the brick shaft. Entry into this level is gained by ladder and through a trap door. Originally, entry into the platform was gained by ascending interior stairs recessed into the brick wall, through an opening in the slate floor to the exterior. There are no handrails on the interior. Although the exterior opening has been sealed, the stairs leading from the original ground-level remain.

The tower widens at the base of the third level, which includes a slate balcony encircled by an iron handrail. The interior of the third level has a slate floor and an interior face that was once whitewashed. The light was located on the fourth floor—the top of the lighthouse—and was reached by an additional flight of radial slate stairs. The top floor is surrounded by a second, small but accessible, cast-iron balcony enclosed with iron railing.

Assessment. The interior circulation system is in very good condition. Inspection shows that:

1. The spiral brick stair support shows no signs of deterioration.
2. The spiral interior slate stairs are in very good condition despite cracks in two of the slate treads. The cracked treads are fully supported structurally and pose no safety hazard.

Probable cause. Nonhomogeneous material with a weak plane that was overloaded.

3. Scattered throughout the lighthouse were various animal remains (bones, skins, and feces) that detract from the appearance. If not corrected, this will result in a deterioration of interior components, continued poor appearance, and an odor that will make it difficult to maintain the structure.

   Probable cause. The nature of the waste indicates that an owl is living in the lighthouse. Federal regulations do not specify treatment for such wastes. Since owls are solitary, the building should simply be cleaned and sealed against animal entry.

Figure 4. Interior stair.

Assessment. The exterior circulation system is in fair condition. Inspection shows that:

1. The slate platform contains some serious cracks and surface delamination (Figure 5). The platform structure is still intact and stable, so there is no apparent danger of pieces falling.

   Probable cause. Nonhomogeneous material with several weak planes combined with effects of the environment. Slate of this (4-in.) thickness will check and split with time. Improper design and installation of metal handrails caused the slate to fracture.

Metalwork: Condition Rating 4

Components. Components of metalwork include the fourth floor balcony floor, handrails around the third and fourth levels, and the framework that held the light

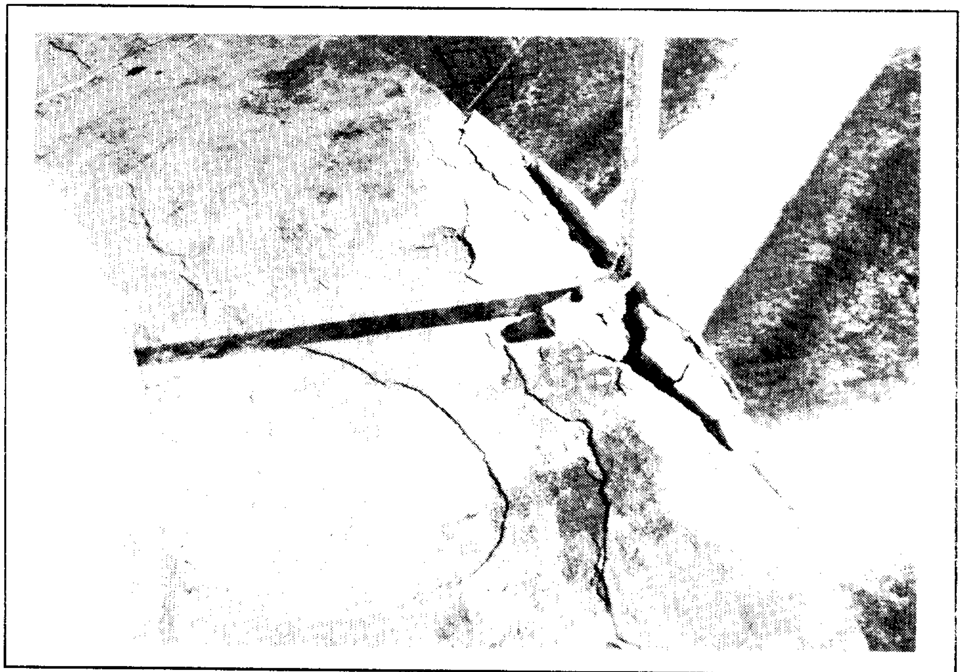

Figure 5. Cracks and surface delamination of slate platform.

in place. The fourth floor balcony consists of 10 radial cast-iron members and cast-iron supports

The top of the lighthouse (Figure 6) is built into the brick drum below to hold it in place. A checkered pattern covers the plates of the balcony and a raised sill is formed in the plates to hold the glass light. A galvanized cast-iron framework supports the fourth level canopy and glazing for the light. The framework is of 1 x 2-1/2-in. members built into the brick walls surrounding the third level. Cast-iron dome ribs bolted onto this framework support the copper canopy of the fourth level. A copper ventilator caps the (apparently original) copper canopy.

Assessment.

The metalwork system is in poor condition. Incompatible replacements are now hazardous with corrosion. Appendix C and Wilkinson (1977) elaborate on Metals Restorations. Findings are:

1. Corrosion or patina is evident on the copper/glass canopy that formally housed the navigation light. Patina is acceptable on historical buildings and is not a concern.

   Probable cause. Chemical reaction between the material and the environment.

2. The metal handrails and ladder suffer from massive corrosion, causing loss of section in some places. The handrails perform adequately, but personnel should use the ladder only in extreme cases.

   Probable cause. The salt winds and the high humidity of the environment.

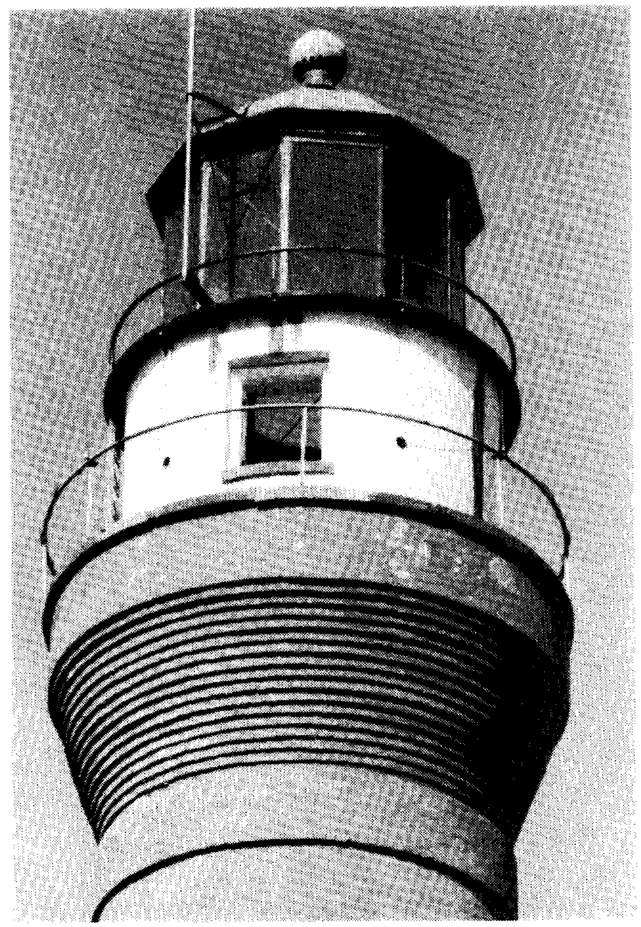

Figure 6. Top of lighthouse.

Windows and Glazing: Condition Rating 4

Components. Four windows penetrate the brick stair tower between the ground level and the first balcony (Figure 7). These windows have wood trim and are double-hung sash, and all have the original wood frames. The windows themselves appear to be replacement windows installed in the restoration of the early 1980s. The present windows are either 4/4, or 6/6. This restoration also replaced the glazing around the light area at the top of the structure. Ten large pieces of plexiglass surround the area, each measuring 2 ft, 7 in. x 5 ft, 8 in.. The cast-iron balcony forms a lip that held the glass in place at the bottom. A cast or wrought iron frame holds in the lite glazing and supports the canopy above. This glazing appeared in good condition.

Assessment. The windows and glazing were both found to be in poor condition. This is mainly due to window detail, the poor quality of replacements, and their subsequent failure. See Appendix C for Wood Window Repair Specifications. Specific conditions follow:

1. All the headers, jams, and sills of the sash windows have peeling paint. All sills are rotting.

   Probable cause. Incompatible replacement windows or installation.

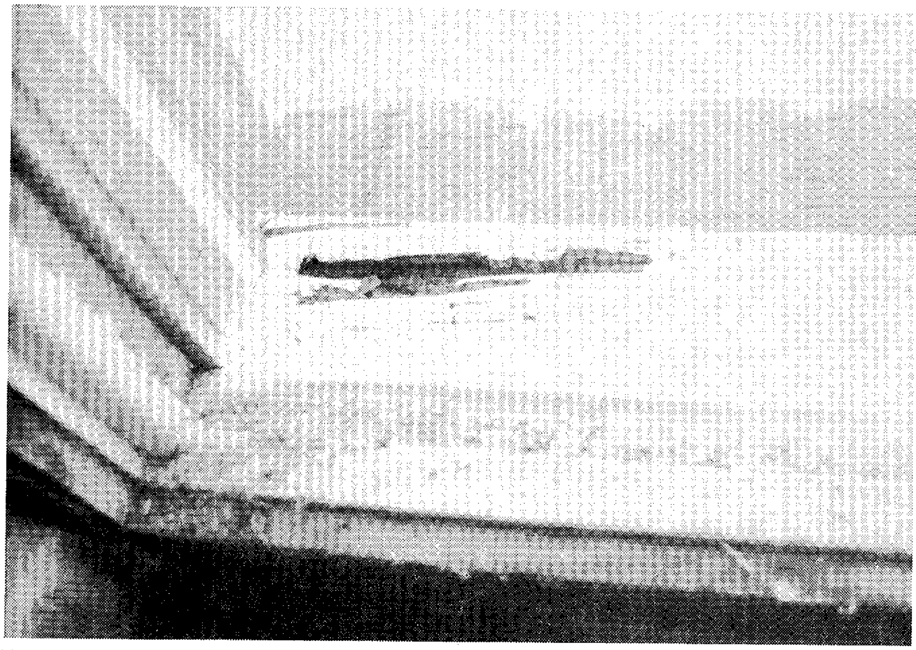

Figure 7. Window detail.

Electrical System: Condition Rating 4

Components. Components included in this system are conduit, wiring, receptacles and the aircraft warning lights.

Assessment. The electrical system is in good condition and functions adequately for the existing use of the lighthouse. However, a major upgrade would be required to reactivate the lighthouse.

Historic Integrity Condition Assessment

Historic integrity identifies those components that make the structure unique and historically important. The condition assessment of this integrity analyzes the structure for components and systems that result in modifications to the original or historic component or system. The fourth degree of modification reflects the most severe compromise of the historic integrity of the structure. Each degree of integrity is defined in four levels. Each definition includes recommendations for treatment. Table 2 lists levels of integrity for the lighthouse systems and components

Table 2. Condition assessment.

System	Complete Integrity	Modified Integrity	Hidden Integrity	Marginal Integrity
Site				Entire system
Exterior Circulation	Cast iron lantern deck	Slate platform with incompatible repair		Replacement cast iron railings
Exterior Closure	Brick masonry; copper canopy and ventilator; cast iron lantern floor; cast iron lantern supports; metal ladders; paint; stucco		Lower 9 to 12 ft of structure buried underground	Replacement wood windows
Interior Construction	Canopy structure; slate floor; slate steps; brick masonry			
Electrical System				Hazard light; lightning rod and cable

Complete Integrity

Spaces or elements with this rating maintain their integrity with only minor intrusions. Therefore, no changes to features are allowed, including: (1) structural elements, e.g., walls, floors, and columns; (2) finishes such as paint; and (3) ornamental items such as copper vents. These features may not be removed, but may be repaired. If they cannot be repaired, they must be replaced to match existing elements. No new features may be added. If a feature has been identified as incompatible or intrusive, it may be removed.

Modified Integrity

Spaces or elements with this rating have had their integrity decreased by incompatible modifications such as (but not limited to) substantial loss of historic finishes or fabric, or additions that change the organization or character of a feature. A Modified rating means that an element either maintains a resemblance of the historic character, or the historic character of the element could be easily re-established by removing the intrusive elements.

In spaces designated as having Modified integrity, modifications to bearing walls, structural elements, contributing ceilings and floors, stairways, and mechanical systems must be designed according to the Secretary of Interior Standards for Historic Preservation. All modifications must also be reviewed by the Historic Preservation Manager to determine if it is necessary to obtain review by the State Historic Preservation Office (SHPO) and Advisory Council on Historic Preservation (ACHP) before work begins.

Hidden Integrity

Spaces or elements with a rating of Hidden Integrity may not contain contributing elements, but it may be suspected that an historic element still exists behind the existing element. If contributing elements are found during any modifications, then the modification requires review by SHPO and ACHP. If none are found, the element may be treated as having Marginal integrity.

Marginal Integrity

Spaces or elements rated as having Marginal Integrity have lost their historic integrity due to modifications, but are considered to be easily reversible. Changes can be made to these elements as long as they do not affect the exterior of the building (such as adding an interior partition that obstructs a window) and as long as they do not affect adjacent spaces with Complete, Modified, or Hidden integrity, such as changing a circulation pattern or cutting an opening in a wall. Structural changes should be made only after considering the overall effect on the building's structural system and equilibrium.

Summary

The inspection and condition assessment procedure shows that the lighthouse is in very good condition, both structurally sound and functionally adequate for its intended use. Minor distresses that will require attention include cleaning the interior of the lighthouse, and repairing the slate platform, metal handrail, and ladder around the top of the lighthouse.

Overall the lighthouse has maintained its historic integrity; apparently intrusions to the integrity are mostly reversible. The original windows and railings are gone, but replicas can be installed to regain the historic appearance. If it is determined to be economically feasible, the fill around the lighthouse can be removed to reveal the base of the structure. The attached building and site context are not likely to be restored. No recommendation is being made to restore these two features.

3 Layaway Plan and Cost Estimate

Introduction

The St. Johns River Lighthouse will be laid away (stored and deactivated) for an indefinite period. During this time, the lighthouse will be maintained in anticipation of future occupancy by the Government or a private organization. The following layaway program will help prevent further building deterioration. It will also help to make future reactivation more cost-effective.

The lighthouse layaway process consists of three phases:

1. Deactivation
2. Periodic Inspection, Maintenance, and Repair
3. Reactivation.

Each phase requires an aggressive building inspection program. The early detection of problems prevents future building failures and the loss of irreplaceable historic building components.

The estimated cost for each phase is included.

Deactivation ($11,725)

During this phase, repairs will be made to stabilize and weatherproof the lighthouse. Building inspections are intended to identify critical repairs, those building failures that must be corrected before the building is allowed to stand vacant. Emphasis is placed on identifying historical component distresses that if not corrected, will begin, continue, or accelerate degradation of other historical components during the layaway period. Such degradation will not only inflate the cost of future maintenance and repair, but may seriously diminish the lighthouse's historic character. This phase includes:

Critical repairs	10450
Superficial repairs	300
Security	0
Environmental concerns	500
Building services	0
Total	$11,250

Critical Repairs ($10,450)

- Repair cracks in slate on tower platform.
- Repair tower metal handrails and ladder. Until repairs are made, POST WARNING SIGNS stating that ladder and handrails are unsafe.
- Patch masonry cracks in the area where a one-story structure formerly joined the lighthouse.
- Remove loose mortar and point masonry in the area where the one-story structure formerly joined the lighthouse.
- Remove loose stucco and re-stucco masonry as needed.
- Repair rotted wood window headers, jams, and sills.
- Scrape and paint all wood windows and frames.

Superficial Repairs ($300)

Remove loose paint and repaint brick below platform on south side of tower.

Security (No change in current costs)

Three security concerns exist during the layaway period: vandalism, graffiti, and theft. The key to minimizing these threats is to keep unauthorized individuals away from the lighthouse area. The following economical measures in conjunction with existing security programs will provide adequate protection for the lighthouse:

1. Signs should be erected to designate the area as off-limits.
2. Security patrols should regularly check the lighthouse for signs of forced entry and vandalism.
3. Materials stored in the lighthouse should be arranged in a neat uniform manner so any disarray can be readily detected at a glance.
4. Electric security system is not necessary, for heavy base security in this area near the airfield is sufficient.

Environmental Concerns ($500)

Before closing-up the lighthouse, remove bird droppings and dead animal remains from the interior. (Close lighthouse when the owl is off the premises.)

Building Services (No change in current costs)

During the layaway period, the lighthouse's electrical service must stay in service to power the exterior hazard lights on the top of the lighthouse. Soffit vents should be sufficient to control moisture, but must be checked periodically to ensure that they are open and clear.

Periodic Inspection, Maintenance, and Repair ($1000/year)

The purpose of periodic inspections and repairs is to reveal any distresses that have occurred since the last inspection. Some detected distresses may be deferred until the lighthouse is reactivated. Depending on severity and rate of degradation, other distresses may require immediate attention (repairs). The inspector's judgment must prevail in reporting deficiencies requiring immediate corrective action. Periodic inspections also provide an opportunity to evaluate and monitor building maintenance conditions while a building is deactivated.

The lighthouse should also be inspected before and after violent storms, extreme changes in outside temperature, area flooding, and area activities that could affect the facility conditions. Any damage discovered should be repaired immediately.

Periodic Inspection ($400)

Periodic inspection should take place every 6 months and after any major storm. The inspection checklist should enable the inspector to inspect the lighthouse in about 2 hours. The annual cost of periodic inspections should be less than $400.

Periodic Maintenance and Repair ($500)

Periodic maintenance and repair should take place after the inspection. Chapter 5 includes an inspection checklist that lists generic repairs to help guide the efforts. Annual cost of repairs is estimated to be around $500.

Ventilation Systems for Historic Buildings

Ventilation in historic buildings is necessary for the same reasons that modern buildings are ventilated—to allow moisture to escape and to allow an exchange of air. A closed environment where moisture is introduced will adversely affect any building material. Damage to the material ranges from dryrot to decomposition of the building material. A National Park Service brochure, *Preservation Brief 24* (Park 1991, also included as Appendix D to this report), describes how the potential for damage grows with the increase in differential between the interior and exterior temperature and humidity levels. This is most prevalent in wooden structures, although over a long period, can affect masonry structures as well.

In St. Johns River Lighthouse, the building materials are common red brick with a lime and natural cement mortar. Moisture resulting from an unventilated environment can affect both materials. Moisture within the building will affect brick minimally, but will directly influence the mortar beds in which the brick is set. The mortar is the most critical part of the masonry system that moisture can affect; once the mortar weakens, the entire masonry system suffers. Two common ways that mortar can deteriorate (and that apply to the St. Johns River Lighthouse) are:

1. The mortar can crumble due to the expansion of clay minerals in the mortar itself. Prolonged contact with moisture can cause the clay minerals to expand, breaking the mortar's original matrix and causing it to lose virtually all of its strength. If the minerals expand quickly, this can also crack the surrounding brick.
2. Mortar can decompose due to the presence and growth of crystals of anionic salts, such as chlorides, sulfates, and nitrates. This often results from contaminated materials used in the mortar mix, such as sea or beach sand with high chloride contents (Weaver 1992). This is a special concern for the St. Johns River Lighthouse.

The exact composition of the mortar used is not known; a detailed chemical analysis was not done. Either of these types of deterioration may occur, resulting in structural deterioration of the building fabric. To avoid this problem at St. Johns River Lighthouse, it is recommended that ventilation be added to the existing structure. In the past, the normal course of activity as the building was opened for use may have given the building adequate ventilation. However, the current deactivation requires installation of new forms of ventilation.

The new form of ventilation must be temporary, for two principal reasons: (1) the deactivation of the lighthouse may only be temporary; if the building were reopened, the natural ventilation of the building in use may again be adequate; (2) the Secretary of the Interior's Standard for Rehabilitation, Standard two states that "The distinguishing original qualities or character of a building, structure, or site and its environment shall not be destroyed. The removal or alteration of any historic material or distinctive architectural features should be avoided when possible." Any permanent venting system that penetrates the masonry walls would directly conflict with the Secretary of Interior's Standards for Rehabilitation. In other words, a permanent system would compromise the integrity of the St. Johns River Lighthouse.

The venting system used should keep the moisture level in the lighthouse low enough to prevent decay of the masonry system, yet high enough to keep the building from drying out—which would promote cracking of the system. A balance that maintains equal interior and exterior moisture level is desirable. It is often the temperature and moisture differentials between the two environments that cause problems in building systems.

4 Inspection Checklist

SITE SYSTEM

Trees and shrubs

Inspect for:

- ☐ Building contact by trees, branches, shrubs, or vegetative growth.

M&R activities as required:

- ☐ Remove or trim all tree, shrub, and vegetative growth in contact with building.

Finish grade

Inspect for:

- ☐ Slope towards building
- ☐ Water accumulation at building.

M&R activities as required

- ☐ Slope grade away from building
- ☐ Provide dam or trench to prevent accumulation at building.

MASONRY SYSTEM

Exterior Closure System

Cementitious coating (stucco)

Inspect for:

- ☐ Cracks and holes
- ☐ Chips and gouges
- ☐ Spalling and scaling
- ☐ Staining and discoloration
- ☐ Efflorescence; locate source of water penetration
- ☐ Damaged expansion joints
- ☐ Surface coat damage.

M&R activities as required:

- ☐ Repair cracks and holes
- ☐ Repair chips and gouges
- ☐ Repair spalled or scaled area
- ☐ Repair expansion joints
- ☐ Clean off surface stains and discoloration
- ☐ Clean off efflorescence
- ☐ Prepare and paint surfaces (when previously painted).

Brick masonry units

Inspect for:

- ☐ Cracks and holes
- ☐ Chips and gouges
- ☐ Broken or missing units
- ☐ Spalling and scaling
- ☐ Cracked, broken, loose, or crumbling mortar
- ☐ Missing mortar
- ☐ Bowing or bulging
- ☐ Out of plumb
- ☐ Staining and discoloration
- ☐ Efflorescence; locate source of water penetration
- ☐ Damaged expansion joints
- ☐ Control joints
- ☐ Clogged weep holes.

MASONRY SYSTEM (Cont'd)

M&R activities as required:

- ☐ Repair cracks and holes
- ☐ Repair chips and gouges
- ☐ Replace broken or missing units
- ☐ Repair spalled or scaled area
- ☐ Remove cracked, broken, loose, or crumbling mortar; repair/point joints
- ☐ Repair/point mortar gaps
- ☐ Tie wall back to main structure
- ☐ Reconstruct failed area
- ☐ Repair damaged expansion joints
- ☐ Clean-out weep holes
- ☐ Clean control joints
- ☐ Clean off surface stains and discoloration
- ☐ Clean off efflorescence.

Interior Construction System

Brick Masonry Units

Inspect for:

- ☐ Cracks and holes
- ☐ Chips and gouges
- ☐ Broken or missing units
- ☐ Spalling and scaling
- ☐ Cracked, broken, loose, or crumbling mortar
- ☐ Missing mortar
- ☐ Bowing or bulging
- ☐ Out of plumb
- ☐ Staining and discoloration
- ☐ Efflorescence; locate source of water penetration
- ☐ Damaged expansion joints
- ☐ Control joints
- ☐ Clogged weep holes.

M&R activities as required:

- ☐ Repair cracks and holes
- ☐ Repair chips and gouges
- ☐ Replace broken or missing units
- ☐ Repair spalled or scaled area
- ☐ Remove cracked, broken, loose, or crumbling mortar; repair/point joints
- ☐ Repair/point mortar gaps
- ☐ Tie wall back to main structure
- ☐ Reconstruct failed area
- ☐ Repair damaged expansion joints
- ☐ Clean-out weep holes
- ☐ Clean control joints
- ☐ Clean off surface stains and discoloration
- ☐ Clean off efflorescence.

CIRCULATION SYSTEM

Slate Platform

Inspect for:

- ☐ Cracks and holes
- ☐ Chips and gouges
- ☐ Spalling and scaling
- ☐ Staining and discoloration
- ☐ Efflorescence; locate source of water penetration
- ☐ Surface coat damage.

M&R activities as required:

- ☐ Repair cracks and holes
- ☐ Repair chips and gouges
- ☐ Repair spalled or scaled area
- ☐ Clean off surface stains and discoloration
- ☐ Clean off efflorescence.

Slate Stair Treads

Inspect for:

- ☐ Cracks and holes
- ☐ Chips and gouges
- ☐ Spalling and scaling
- ☐ Staining and discoloration
- ☐ Efflorescence; locate source of water penetration
- ☐ Surface coat damage.

M&R activities as required:

- ☐ Repair cracks and holes
- ☐ Repair chips and gouges
- ☐ Repair spalled or scaled area
- ☐ Clean off surface stains and discoloration
- ☐ Clean off efflorescence.

METALWORK SYSTEM

Steel Guardrails, Handrails, and Ladder

Inspect for:

- ☐ Cracks, holes, dents, and deformation
- ☐ Corrosion
- ☐ Staining and discoloration
- ☐ Loose, broken, or missing sections and fasteners
- ☐ Surface coat damage.

M&R activities as required:

- ☐ Repair cracks, holes, dents, and deformation
- ☐ Remove corrosion
- ☐ Secure loose sections and fasteners
- ☐ Replace broken or missing sections and fasteners
- ☐ Clean off surfaces stains and discoloration
- ☐ Clean surfaces
- ☐ Prepare surface and paint when previously painted

Copper Metal Cladding

Inspect for:

- ☐ Cracks, holes, dents, and gouges
- ☐ Staining and discoloration
- ☐ Corrosion
- ☐ Deformed sections
- ☐ Loose, broken, or missing sections and fasteners
- ☐ Surface coat damage.

M&R activities as required:

- ☐ Patch small cracks and holes; replace sections with large cracks and holes
- ☐ Replace sections with dents or gouges
- ☐ Remove corrosion
- ☐ Replace deformed sections
- ☐ Secure loose sections and fasteners
- ☐ Replace broken or missing sections and fasteners
- ☐ Clean off surface stains and discoloration
- ☐ Prepare and paint surfaces when previously painted).

WINDOWS AND GLAZING SYSTEM

Wood Windows

Inspect for:

- ☐ Cracks, splits, and holes
- ☐ Warp
- ☐ Staining and discoloration
- ☐ Rot and fungal growth
- ☐ Insect infestation
- ☐ Loose sections and loose or missing fasteners
- ☐ Broken or missing sections
- ☐ Open joints
- ☐ Surface coat damage.

M&R activities as required:

- ☐ Repair cracks, splits, and holes
- ☐ Refinish surfaces
- ☐ Remove rot and replace sections
- ☐ Secure loose sections and loose or missing fasteners
- ☐ Replace broken or missing sections
- ☐ Tighten open joints
- ☐ Eradicate insect infestation
- ☐ Clean off fungus growth
- ☐ Clean off surface stains and discoloration
- ☐ Clean surfaces
- ☐ Prepare surfaces and paint (when previously painted).

Glass and Glazing

Inspect for:

- ☐ Broken or missing glass
- ☐ Broken or missing glazing
- ☐ Double glazing seal failure.

M&R activities as required:

- ☐ Replace broken or missing glass and glazing, and sealed units
- ☐ Clean surfaces.

ELECTRICAL SYSTEM

Inspect for:

- ☐ Ensure power is on to aircraft warning lights
- ☐ Ensure aircraft warning lights are working properly
- ☐ Breaker panel moisture, animal intrusion/degradation
- ☐ Lights, outlets and switches for corrosion or other degradation.

M&R activities as required:

- ☐ Repair aircraft warning lights as required
- ☐ Seal circuit breaker to prevent further moisture
- ☐ Replace/repair all lights, outlets, and switches.

5 Reactivation

Procedure

During reactivation, the lighthouse is reopened. Reactivation inspections identify defects that must be corrected before the building can again be occupied. These procedures are necessary to preserve the lighthouse's historic character and provide the maximum degree of facility usability. The following existing building distresses are to be added to deferred distresses discovered during the layaway period, which should then be corrected before the lighthouse is reactivated:

- Remove dirt fill around lighthouse base; coordinate with archeological records.
- Install retaining walls to hold back grade from lighthouse base.
- Landscape area around lighthouse base to promote positive drainage.
- Repair brick walls which were underground at base of lighthouse.
- Re-establish door entrance at base of lighthouse (remove bricked-up door opening), at an estimated cost of $1050.00.
- Clean glass and copper around lantern room.

Estimated Cost

The estimated cost to reactivate the lighthouse is $11,900.

6 Conclusions and Recommendations

This research evaluated the condition of the St. Johns River Lighthouse and developed a preservation plan for base engineers and cultural resource personnel to maintain the this cultural resource so it may someday be restored to productive use.

An inspection and condition assessment showed the lighthouse to be in very good condition. Minor distresses requiring immediate attention include cleaning the interior of the lighthouse, and repairing the slate platform, metal handrail, and ladder around the top of the lighthouse. Overall, the lighthouse has maintained its historic integrity; apparent intrusions to the integrity are mostly reversible. The original windows and railings are gone, but replicas can be installed to regain the historic appearance. The fill around the lighthouse can be removed to reveal the base of the structure. The keeper's house and site context are not likely to be restored. No recommendation is being made to restore these two features.

The layaway plan to cost-effectively preserve this cultural resource includes:

1. **Deactivation ($11,725).** The lighthouse has already been deactivated. To complete the deactivation process the following items should be addressed: critical repairs, repairs to minor distresses, ventilation, security, environmental concerns, and building services.

2. **Periodic Inspection, Maintenance, and Repair ($1000/year).** A inspection checklist was developed to help base engineers and cultural resource personnel maintain the lighthouse during the layaway period. While deactivated, the structure should be inspected twice a year and after any severe storm. Failures identified during the inspections should be addressed by identifying and addressing the cause of any problems.

3. **Reactivation ($11,900).** A number of noncritical repairs are necessary if this structure is ever to be reactivated.

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Appendix A: The Secretary of the Interior's Standards for the Treatment of Historic Properties 1992

Source

These standards are taken from the U.S. Department of the Interior leaflet, *The Secretary of the Interior's Standards for the Treatment of Historical Properties 1992*, which is the current revision of the *Federal Register Notice*, vol 48, No. 190 (September 1983).

Treatments

Preservation focuses on the maintenance and repair of existing historic materials retention of a property's form as it has evolved over time. (Protection and Stabilization have now been consolidated under this treatment.) **Rehabilitation** acknowledges the need to alter or add to a historic property to meet continuing or changing uses while retaining the property's historic character. **Restoration** is undertaken to depict a property at a particular period of time in its history while removing evidence of other periods.

Standards for Preservation

Preservation is defined as the act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials and features rather than extensive replacement and new construction. New exterior additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project.

- A property shall be used as it was historically, or be given a new use that maximizes the retention of distinctive materials, features, spaces, and spatial relationships. Where a treatment and use have not been identified, a property shall be protected and, if necessary, stabilized until additional work may be undertaken.

- The historic character of a property shall be retained and preserved. The replacement of intact or repairable historic materials or alteration of features, spaces, and spatial relationships that characterize a property shall be avoided.

- Each property shall be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate, and conserve existing historic materials and features shall be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.

- Changes to a property that have acquired historic significance in their own right shall be retained and preserved.

- Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.

- The existing condition of historic features shall be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration requires repair or limited replacement of a distinctive feature, the new material shall match the old in composition, design, color, and texture.

- Chemical or physical treatments, if appropriate, shall be undertaken using the gentlest means possible. Treatments that cause damage to historic materials shall not be used.

- Archeological resources shall be protected and preserved in place. If such resources must be disturbed, mitigation measures shall be undertaken.

Standards for Rehabilitation

Rehabilitation is defined as the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values.

- A property shall be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.

- The historic character of a property shall be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property shall be avoided.

- Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, shall not be undertaken.

- Changes to a property that have acquired historic significance in their own right shall be retained and preserved.

- Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.

- Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and, where possible, materials. Replacement of missing features shall be substantiated by documentary and physical evidence.

- Chemical or physical treatments, if appropriate, shall be undertaken using the gentlest means possible. Treatments that cause damage to historic materials shall not be used.

- Archeological resources shall be protected and preserved in place. If such resources must be disturbed, mitigation measures shall be undertaken.

- New additions, exterior alterations, or related new construction shall not destroy historic materials, features, and spatial relationships that characterize the property. The new work shall be differentiated from the old and shall be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.

- New additions and adjacent or related new construction shall be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

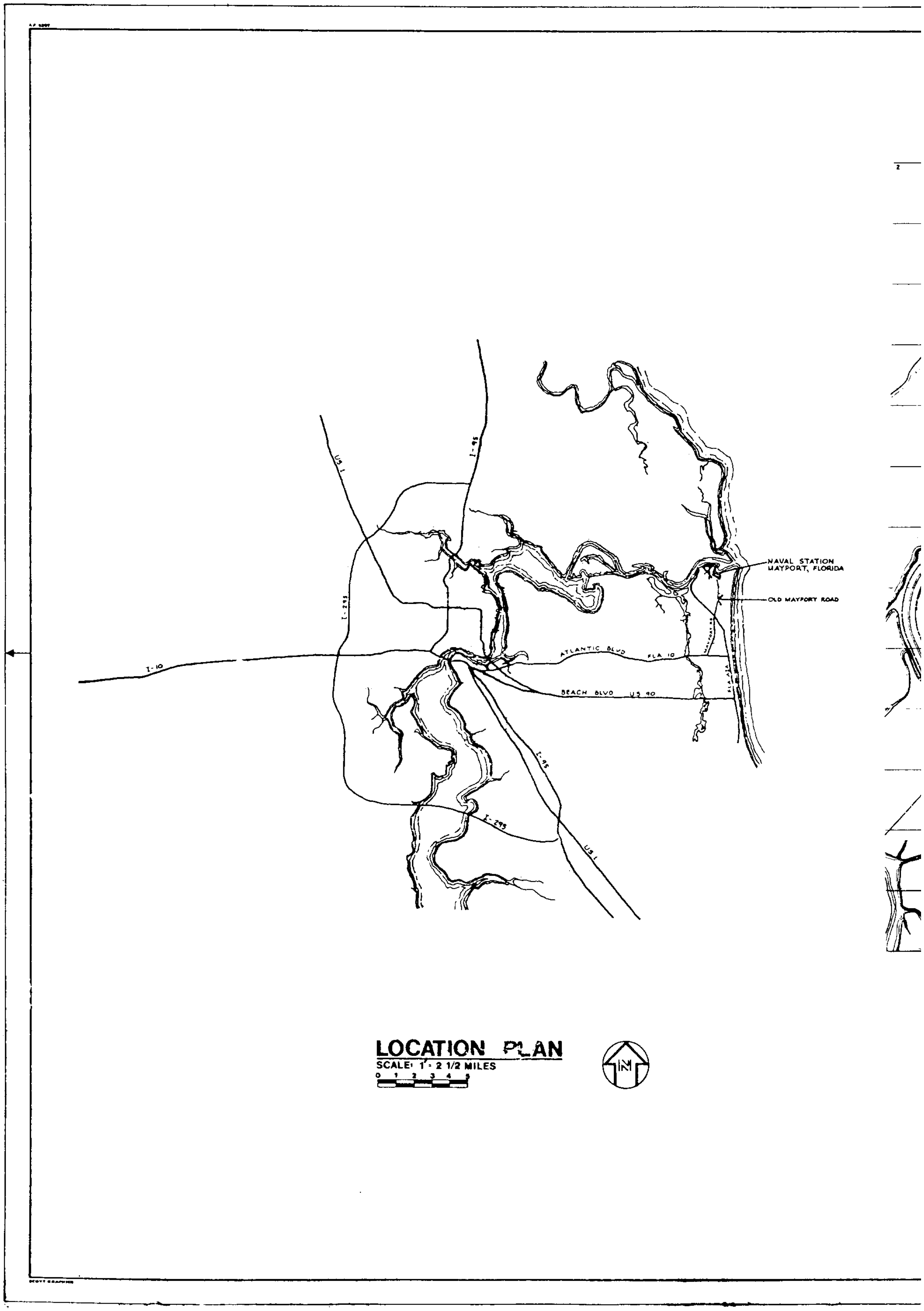
Standards for Restoration

Restoration is defined as the act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features form the restoration period. The limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a restoration project.

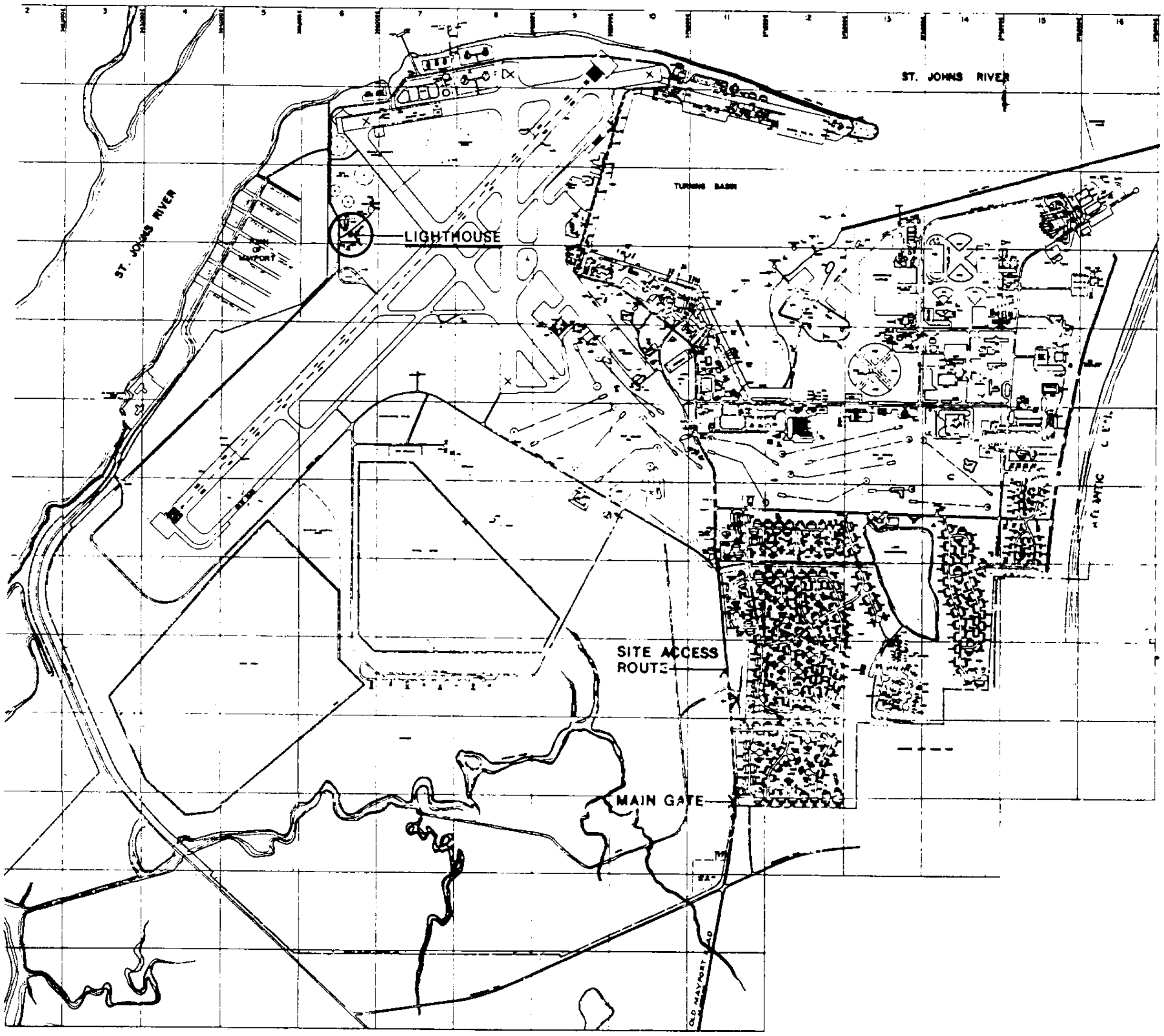
- A property shall be used as it was historically or be given a new use which reflects the property's restoration period.
- Materials and features from the restoration period shall be retained and preserved. The removal of materials or alteration of features, spaces, and spatial relationships that characterize the period shall not be undertaken.
- Each property shall be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate and conserve materials and features form the restoration period shall be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.
- Materials, features, spaces, and finishes that characterize other historical periods shall be documented prior to their alteration or removal.
- Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize the restoration period shall be preserved.
- Deteriorated features from the restoration period shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and, where possible, materials.
- Replacement of missing features from the restoration period shall be substantiated by documentary and physical evidence. A false sense of history shall not be created by adding conjectural features, features from other properties, or by combining features that never existed together historically.
- Chemical or physical treatments, if appropriate, shall be undertaken using the gentlest means possible. Treatments that cause damage to historic materials shall not be used.
- Archeological resources affected by a project shall be protected and preserved in place. If such resources must be disturbed, mitigation measures shall be undertaken.
- Designs that were never executed historically shall not be constructed.

Appendix B: Recent Restoration Projects

In 1980 and 1982 restoration work was done on the lighthouse. The plans for those two projects are on the following 4 pull-out pages. Sheet 1 of 2 for the 1980 project has been intentionally left out. Sheet 1 of 2 is a site map which is the same as sheet 1 of 3 for the 1982 project.


NAVAL STATION
MAYPORT, FLORIDA
OLD MAYPORT ROAD
ATLANTIC BLVD
FLA 10
BEACH BLVD
US 90
I-10
I-95
US 1
I-295
LOCATION PLAN
SCALE: 1" = 2 1/2 MILES
0 1 2 3 4 5

REVISIONS				
LET	DESCRIPTION	PREP'D BY	DATE	APPROVED
	DWG. CORRECTED TO AS-BUILT	TURNER	7-982	AMT



VICINITY MAP

SCALE: 1" = 80'

0 20 40 80 160

DATE 15 JUL 1982

ARCH & ENGR SEAL

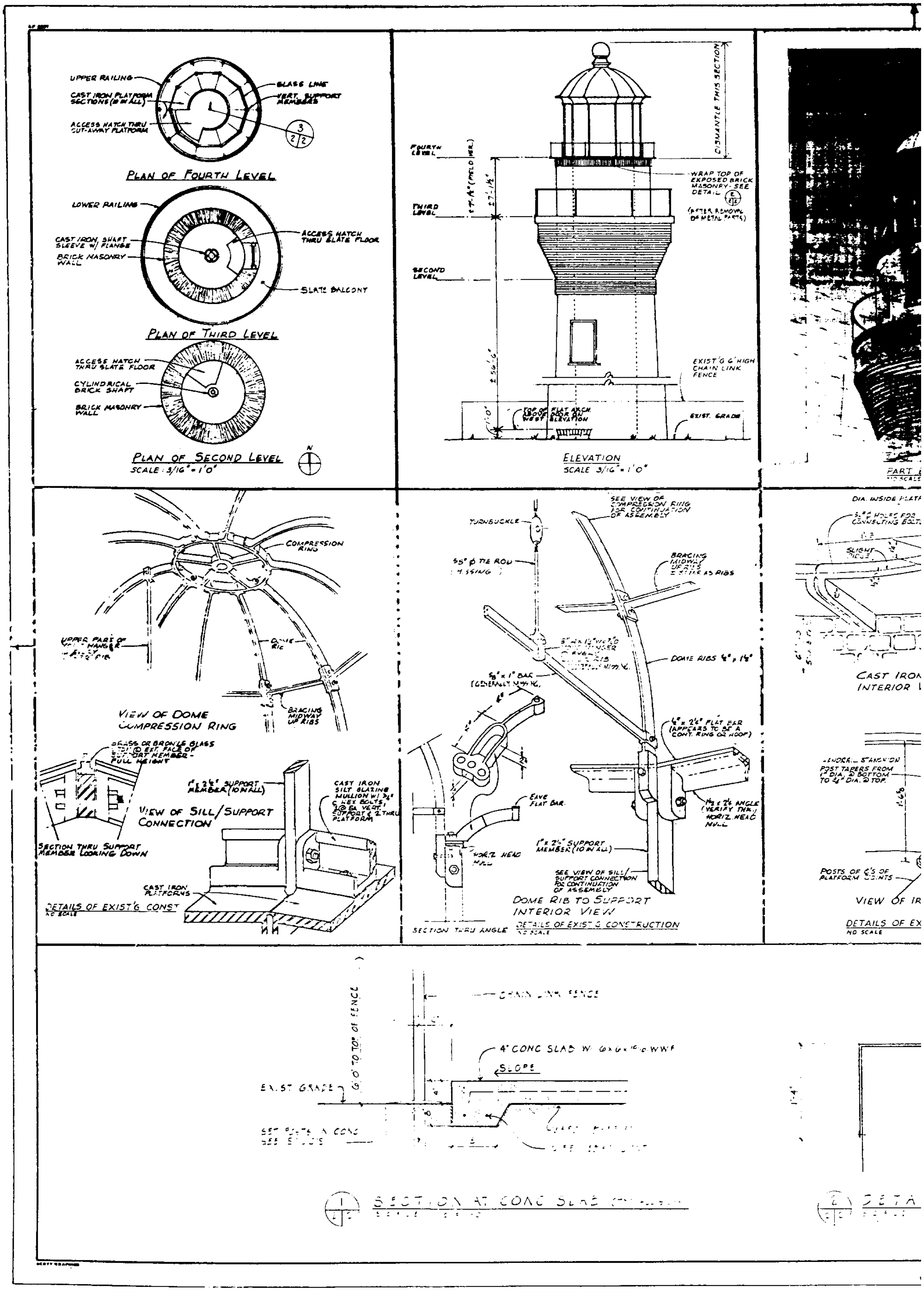
SHEPARD ASSOCIATES
ARCHITECTS AND PLANNERS, INC.
2111 CORPORATE SQUARE BLVD
JACKSONVILLE, FLORIDA / 32216

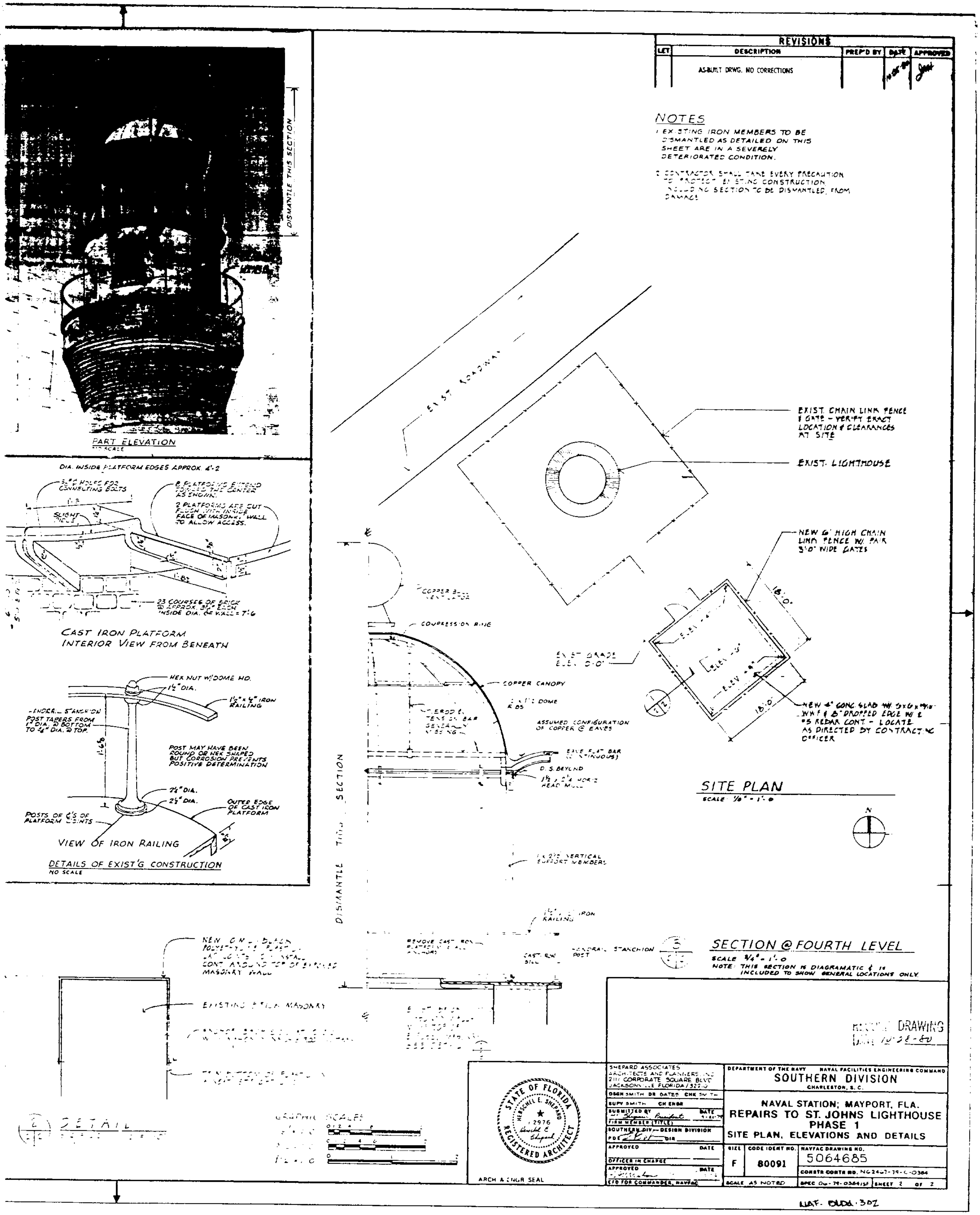
DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
SOUTHERN DIVISION
CHARLESTON, S. C.

NAVAL STATION, MAYPORT, FLA.
[redacted]
LOCATION AND VICINITY PLANS

SIZE	CODE IDENT NO.	NAVFAC DRAWING NO.
F	80091	

SCALE AS NOTED


UPPER RAILING
CAST IRON PLATFORM SECTIONS (8 IN ALL)
ACCESS HATCH THRU CUT-AWAY PLATFORM
GLASS LINE
VERT. SUPPORT MEMBERS
PLAN OF FOURTH LEVEL
LOWER RAILING
CAST IRON SHAFT SLEEVE W/ FLANGE
BRICK MASONRY WALL
ACCESS HATCH THRU SLATE FLOOR
SLATE BALCONY
PLAN OF THIRD LEVEL
ACCESS HATCH THRU SLATE FLOOR
CYLINDRICAL BRICK SHAFT
BRICK MASONRY WALL
PLAN OF SECOND LEVEL
SCALE: 3/16" = 1'0"
DISMANTLE THIS SECTION
FOURTH LEVEL
THIRD LEVEL
SECOND LEVEL
WRAP TOP OF EXPOSED BRICK MASONRY - SEE DETAIL
EXIST'G 6' HIGH CHAIN LINK FENCE
EXIST. GRADE
ELEVATION
SCALE 3/16" = 1'0"
COMPRESSION RING
VIEW OF DOME COMPRESSION RING
BRACING MIDWAY UP RIBS
VIEW OF SILL/SUPPORT CONNECTION
SECTION THRU SUPPORT MEMBER LOOKING DOWN
CAST IRON PLATFORMS
DETAILS OF EXIST'G CONST
TURNBUCKLE
DOME RIBS
EAVE FLAT BAR
DOME RIB TO SUPPORT INTERIOR VIEW
DETAILS OF EXIST'G CONSTRUCTION
SECTION THRU ANGLE
CAST IRON
INTERIOR
DETAILS OF EX
NO SCALE
CHAIN LINK FENCE
4" CONC SLAB
SLOPE
EXIST GRADE
6'-0" TO TOP OF FENCE
SECTION AT CONC SLAB


REVISIONS
LET
DESCRIPTION
PREP'D BY
DATE
APPROVED
AS-BUILT DRWG. NO CORRECTIONS
NOTES
1. EXISTING IRON MEMBERS TO BE DISMANTLED AS DETAILED ON THIS SHEET ARE IN A SEVERELY DETERIORATED CONDITION.
EXIST. CHAIN LINK FENCE & GATE - VERIFY EXACT LOCATION & CLEARANCES AT SITE
EXIST. LIGHTHOUSE
NEW 6' HIGH CHAIN LINK FENCE W/ PAIR 3'-0" WIDE GATES
NEW 4" CONC SLAB
SITE PLAN
SECTION @ FOURTH LEVEL
NOTE: THIS SECTION IS DIAGRAMATIC & IS INCLUDED TO SHOW GENERAL LOCATIONS ONLY
COPPER CANOPY
ASSUMED CONFIGURATION OF COPPER @ EAVES
DISMANTLE THIS SECTION
PART ELEVATION
DIA. INSIDE PLATFORM EDGES APPROX. 4'-2"
2 PLATFORMS ARE CUT FLUSH WITH INSIDE FACE OF MASONRY WALL TO ALLOW ACCESS.
CAST IRON PLATFORM INTERIOR VIEW FROM BENEATH
HEX NUT W/DOME HD.
1½" DIA.
POST MAY HAVE BEEN ROUND OR HEX SHAPED BUT CORROSION PREVENTS POSITIVE DETERMINATION
OUTER EDGE OF CAST IRON PLATFORM
VIEW OF IRON RAILING
DETAILS OF EXIST'G CONSTRUCTION
NO SCALE
EXISTING BRICK MASONRY
DETAIL
GRAPHIC SCALES
DRAWING
10-28-80
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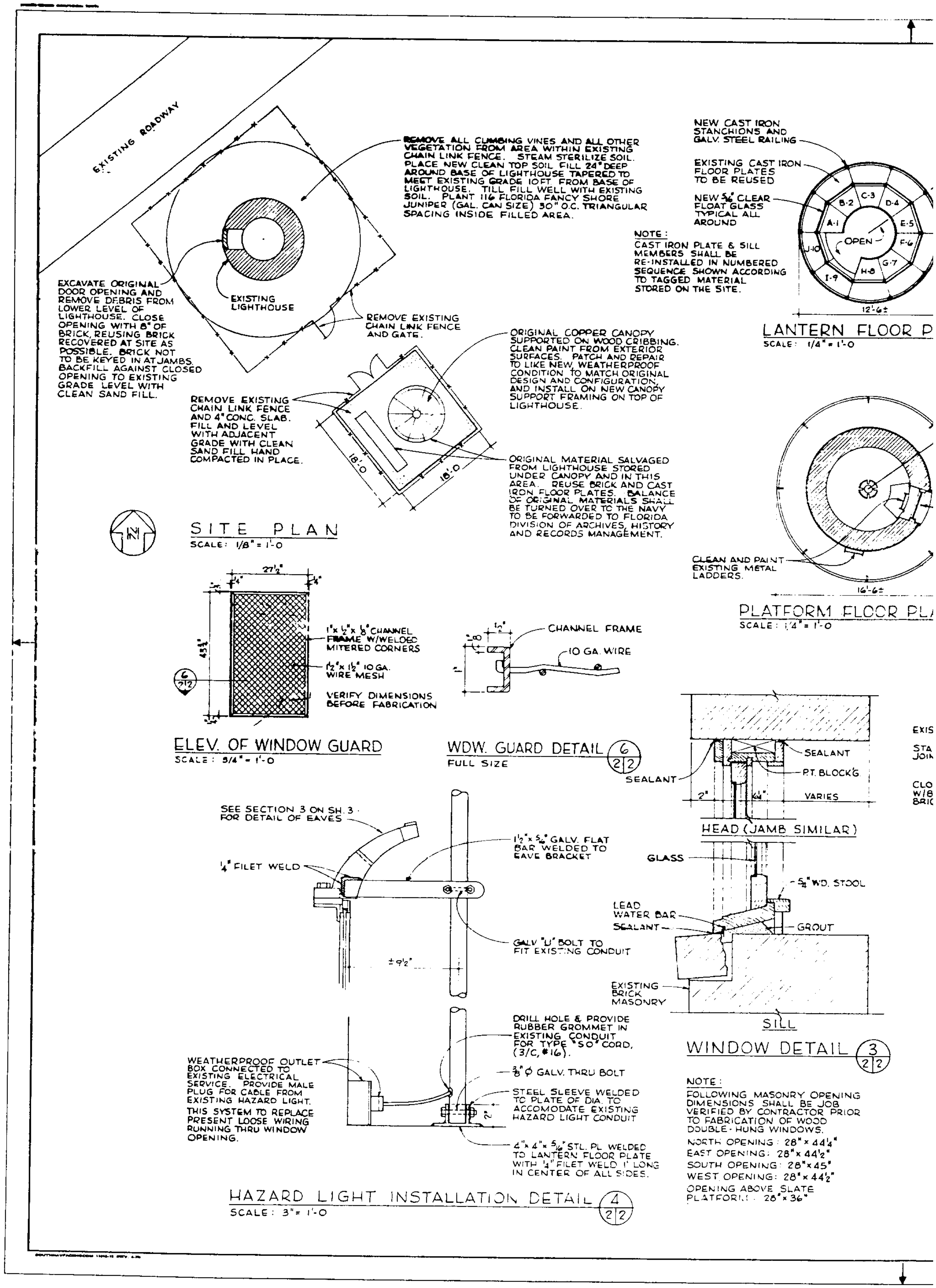
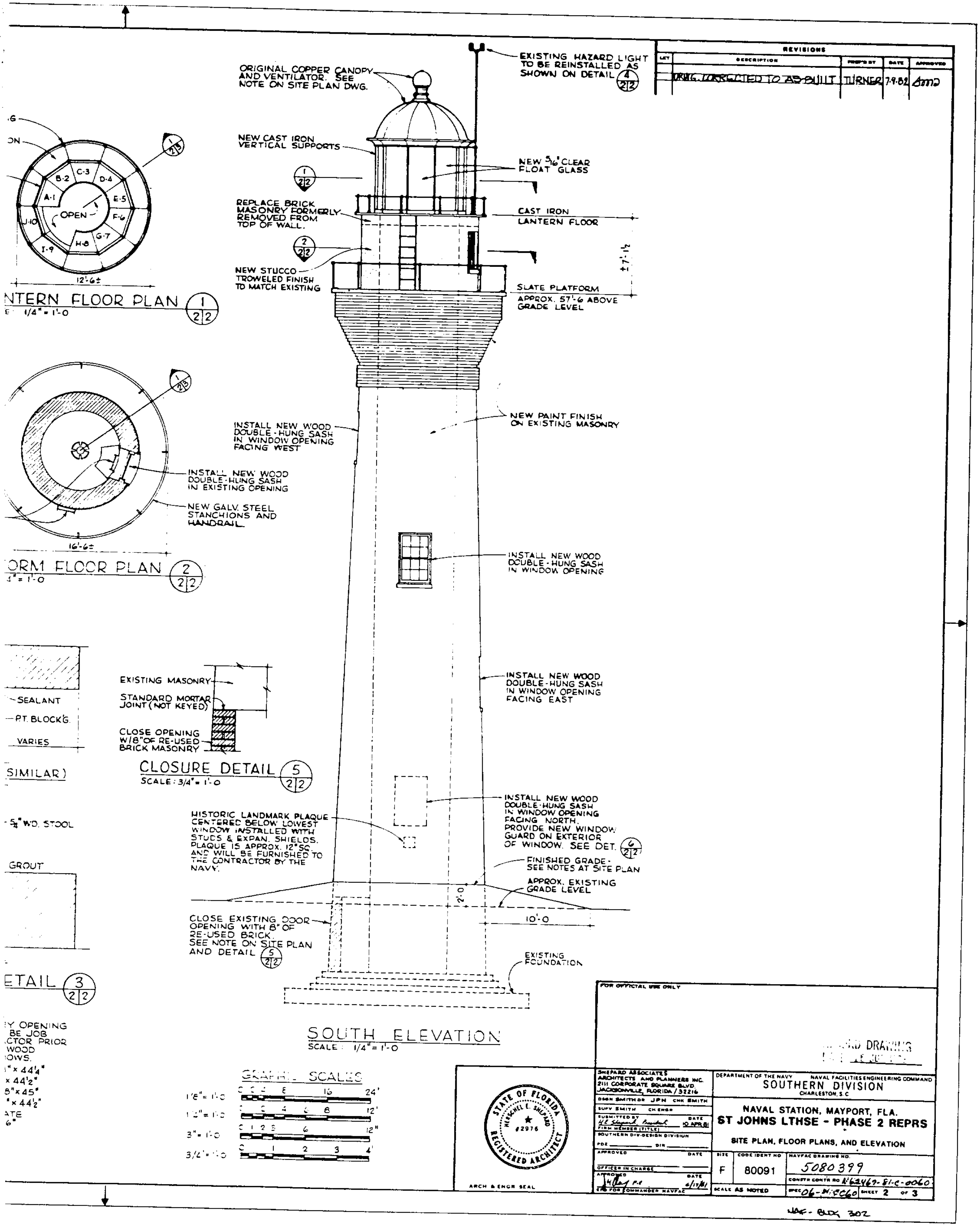
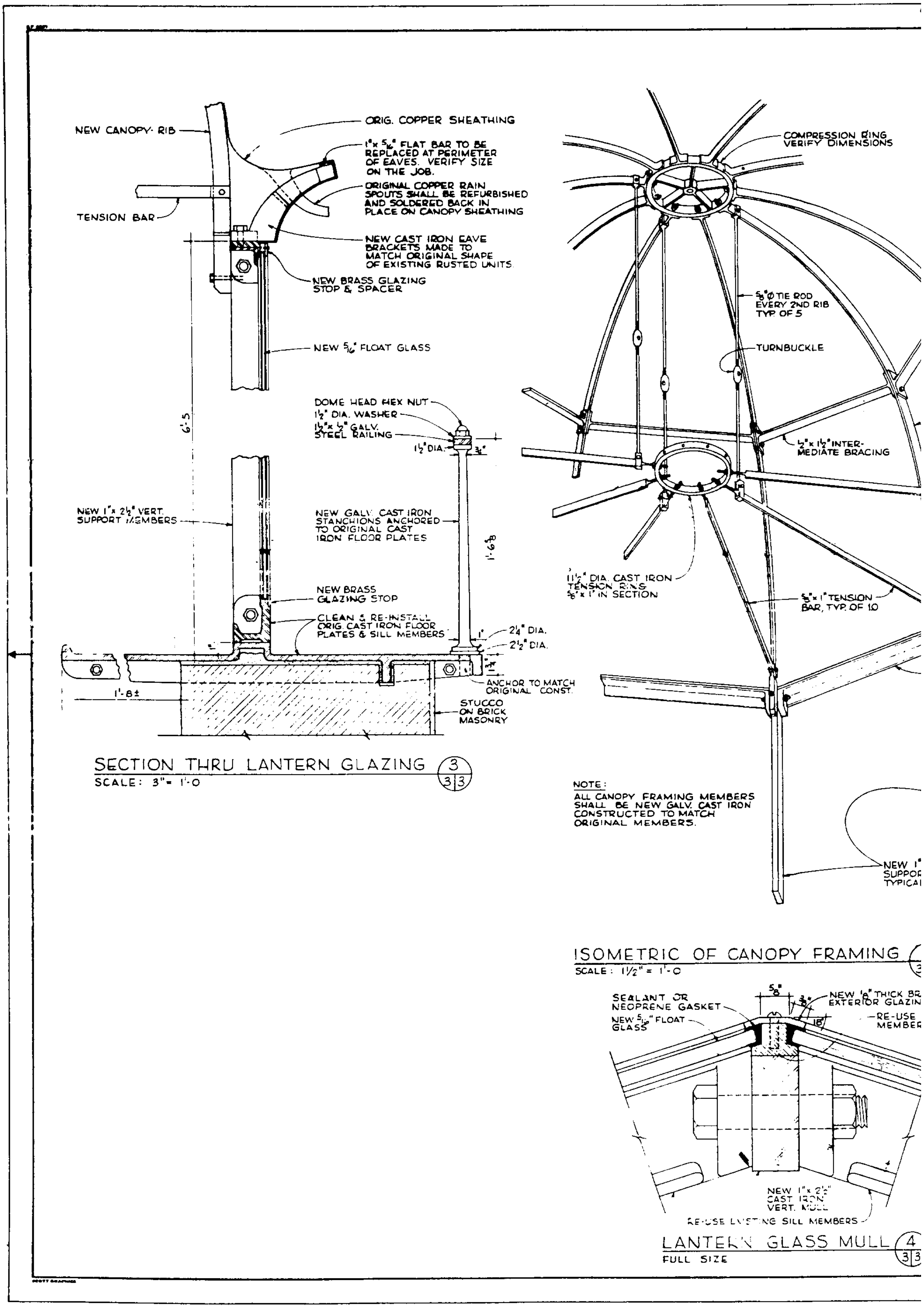
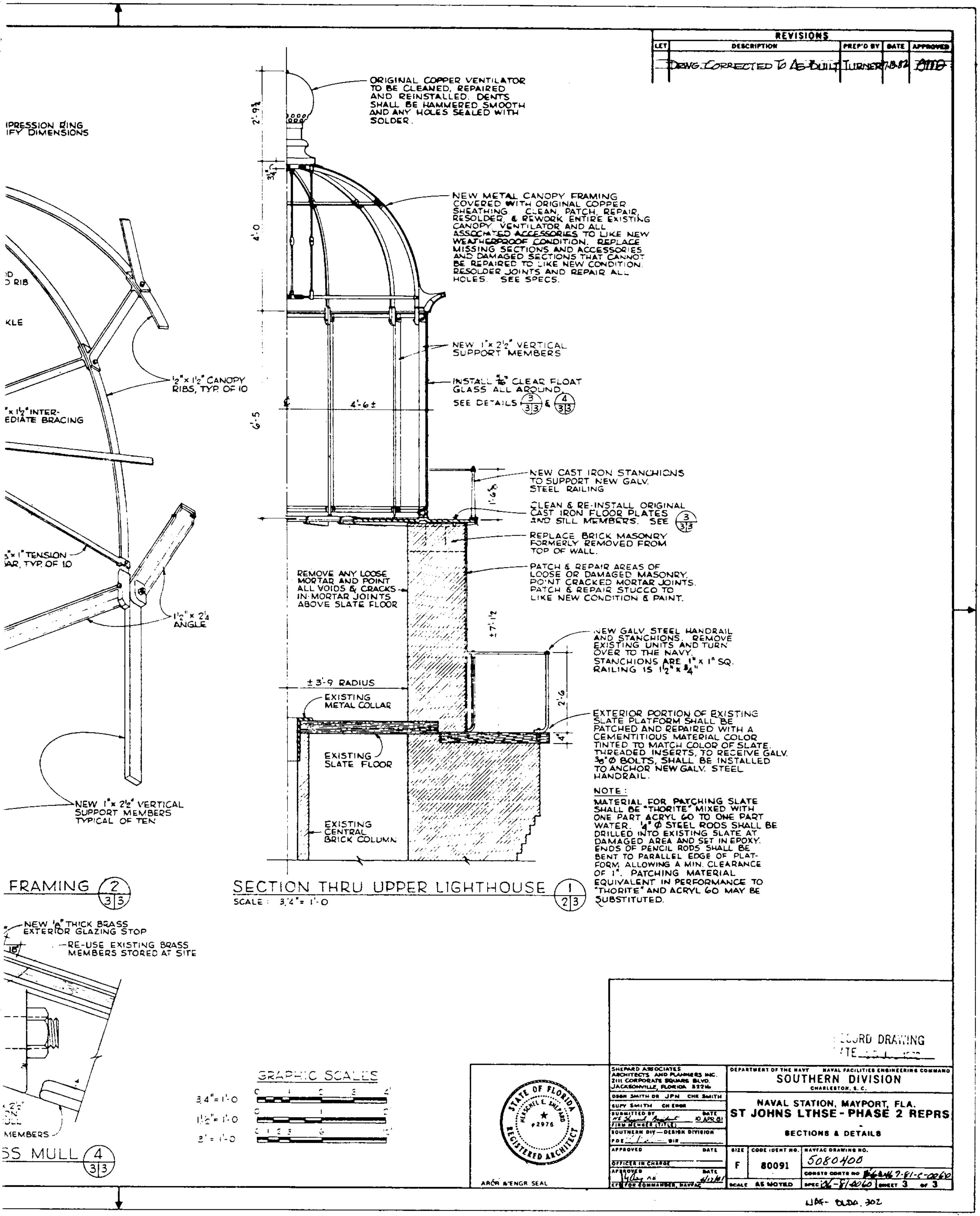
NAVAL FACILITIES ENGINEERING COMMAND
SOUTHERN DIVISION
CHARLESTON, S. C.
NAVAL STATION; MAYPORT, FLA.
REPAIRS TO ST. JOHNS LIGHTHOUSE
PHASE 1
SITE PLAN, ELEVATIONS AND DETAILS
SIZE F
CODE IDENT NO. 80091
NAVFAC DRAWING NO. 5064685
SCALE AS NOTED
SHEET 2 OF 2


EXISTING ROADWAY
REMOVE ALL CLIMBING VINES AND ALL OTHER VEGETATION FROM AREA WITHIN EXISTING CHAIN LINK FENCE. STEAM STERILIZE SOIL. PLACE NEW CLEAN TOP SOIL FILL 24" DEEP AROUND BASE OF LIGHTHOUSE TAPERED TO MEET EXISTING GRADE 10 FT FROM BASE OF LIGHTHOUSE. TILL FILL WELL WITH EXISTING SOIL. PLANT 116 FLORIDA FANCY SHORE JUNIPER (GAL. CAN SIZE) 30" O.C. TRIANGULAR SPACING INSIDE FILLED AREA.
EXCAVATE ORIGINAL DOOR OPENING AND REMOVE DEBRIS FROM LOWER LEVEL OF LIGHTHOUSE. CLOSE OPENING WITH 8" OF BRICK, REUSING BRICK RECOVERED AT SITE AS POSSIBLE. BRICK NOT TO BE KEYED IN AT JAMBS. BACKFILL AGAINST CLOSED OPENING TO EXISTING GRADE LEVEL WITH CLEAN SAND FILL.
EXISTING LIGHTHOUSE
REMOVE EXISTING CHAIN LINK FENCE AND GATE.
ORIGINAL COPPER CANOPY SUPPORTED ON WOOD CRIBBING. CLEAN PAINT FROM EXTERIOR SURFACES. PATCH AND REPAIR TO LIKE NEW, WEATHERPROOF CONDITION TO MATCH ORIGINAL DESIGN AND CONFIGURATION, AND INSTALL ON NEW CANOPY SUPPORT FRAMING ON TOP OF LIGHTHOUSE.
REMOVE EXISTING CHAIN LINK FENCE AND 4" CONC. SLAB. FILL AND LEVEL WITH ADJACENT GRADE WITH CLEAN SAND FILL HAND COMPACTED IN PLACE.
18'-0
18'-0
ORIGINAL MATERIAL SALVAGED FROM LIGHTHOUSE STORED UNDER CANOPY AND IN THIS AREA. REUSE BRICK AND CAST IRON FLOOR PLATES. BALANCE OF ORIGINAL MATERIALS SHALL BE TURNED OVER TO THE NAVY TO BE FORWARDED TO FLORIDA DIVISION OF ARCHIVES, HISTORY AND RECORDS MANAGEMENT.
N
SITE PLAN
SCALE: 1/8" = 1'-0
NEW CAST IRON STANCHIONS AND GALV. STEEL RAILING
EXISTING CAST IRON FLOOR PLATES TO BE REUSED
NEW 5/16" CLEAR FLOAT GLASS TYPICAL ALL AROUND
NOTE: CAST IRON PLATE & SILL MEMBERS SHALL BE RE-INSTALLED IN NUMBERED SEQUENCE SHOWN ACCORDING TO TAGGED MATERIAL STORED ON THE SITE.
A-1 B-2 C-3 D-4 E-5 F-6 G-7 H-8 I-9 J-10
OPEN
12'-6±
LANTERN FLOOR P
SCALE: 1/4" = 1'-0
CLEAN AND PAINT EXISTING METAL LADDERS.
16'-6±
PLATFORM FLOOR PL
SCALE: 1/4" = 1'-0
27½"
43¾"
1" x ½" x ⅛" CHANNEL FRAME W/WELDED MITERED CORNERS
1½" x 1½" 10 GA. WIRE MESH
VERIFY DIMENSIONS BEFORE FABRICATION
ELEV. OF WINDOW GUARD
SCALE: 3/4" = 1'-0
CHANNEL FRAME
10 GA. WIRE
WDW. GUARD DETAIL 6/2|2
FULL SIZE
SEALANT
P.T. BLOCK'G
VARIES
HEAD (JAMB SIMILAR)
GLASS
5/4" WD. STOOL
LEAD WATER BAR
SEALANT
GROUT
EXISTING BRICK MASONRY
SILL
WINDOW DETAIL 3/2|2
EXIS
STA JOIN
CLO W/8 BRIC
NOTE: FOLLOWING MASONRY OPENING DIMENSIONS SHALL BE JOB VERIFIED BY CONTRACTOR PRIOR TO FABRICATION OF WOOD DOUBLE-HUNG WINDOWS.
NORTH OPENING: 28" x 44¼"
EAST OPENING: 28" x 44½"
SOUTH OPENING: 28" x 45"
WEST OPENING: 28" x 44½"
OPENING ABOVE SLATE PLATFORM: 28" x 36"
SEE SECTION 3 ON SH. 3 FOR DETAIL OF EAVES
¼" FILET WELD
1½" x 5/16" GALV. FLAT BAR WELDED TO EAVE BRACKET
GALV. "U" BOLT TO FIT EXISTING CONDUIT
±9½"
DRILL HOLE & PROVIDE RUBBER GROMMET IN EXISTING CONDUIT FOR TYPE "SO" CORD, (3/C, #16).
⅜" Ø GALV. THRU BOLT
STEEL SLEEVE WELDED TO PLATE OF DIA. TO ACCOMODATE EXISTING HAZARD LIGHT CONDUIT
WEATHERPROOF OUTLET BOX CONNECTED TO EXISTING ELECTRICAL SERVICE. PROVIDE MALE PLUG FOR CABLE FROM EXISTING HAZARD LIGHT. THIS SYSTEM TO REPLACE PRESENT LOOSE WIRING RUNNING THRU WINDOW OPENING.
4" x 4" x 5/16" STL. PL. WELDED TO LANTERN FLOOR PLATE WITH ¼" FILET WELD 1" LONG IN CENTER OF ALL SIDES.
HAZARD LIGHT INSTALLATION DETAIL 4/2|2
SCALE: 3" = 1'-0


EXISTING HAZARD LIGHT TO BE REINSTALLED AS SHOWN ON DETAIL 4 2|2
ORIGINAL COPPER CANOPY AND VENTILATOR. SEE NOTE ON SITE PLAN DWG.
REVISIONS
DESCRIPTION
DATE
APPROVED
DRWG. CORRECTED TO AS-BUILT
TURNER
7-9-82
NEW CAST IRON VERTICAL SUPPORTS
NEW 5/16" CLEAR FLOAT GLASS
REPLACE BRICK MASONRY FORMERLY REMOVED FROM TOP OF WALL.
CAST IRON LANTERN FLOOR
NEW STUCCO TROWELED FINISH TO MATCH EXISTING
±7'-1½
SLATE PLATFORM
APPROX. 57'-6 ABOVE GRADE LEVEL
B-2
C-3
D-4
A-1
E-5
OPEN
F-6
J-10
G-7
I-9
H-8
12'-6±
NTERN FLOOR PLAN 1 2|2
1/4" = 1'-0
INSTALL NEW WOOD DOUBLE-HUNG SASH IN WINDOW OPENING FACING WEST
NEW PAINT FINISH ON EXISTING MASONRY
INSTALL NEW WOOD DOUBLE-HUNG SASH IN EXISTING OPENING
NEW GALV. STEEL STANCHIONS AND HANDRAIL
16'-6±
ORM FLOOR PLAN 2 2|2
1/4" = 1'-0
INSTALL NEW WOOD DOUBLE-HUNG SASH IN WINDOW OPENING
SEALANT
PT. BLOCK'G.
VARIES
EXISTING MASONRY
STANDARD MORTAR JOINT (NOT KEYED)
CLOSE OPENING W/8" OF RE-USED BRICK MASONRY
INSTALL NEW WOOD DOUBLE-HUNG SASH IN WINDOW OPENING FACING EAST
SIMILAR)
CLOSURE DETAIL 5 2|2
SCALE: 3/4" = 1'-0
5/4" WD. STOOL
HISTORIC LANDMARK PLAQUE CENTERED BELOW LOWEST WINDOW INSTALLED WITH STUDS & EXPAN. SHIELDS. PLAQUE IS APPROX. 12" SQ. AND WILL BE FURNISHED TO THE CONTRACTOR BY THE NAVY.
INSTALL NEW WOOD DOUBLE-HUNG SASH IN WINDOW OPENING FACING NORTH. PROVIDE NEW WINDOW GUARD ON EXTERIOR OF WINDOW. SEE DET. 6 2|2
GROUT
FINISHED GRADE - SEE NOTES AT SITE PLAN
APPROX. EXISTING GRADE LEVEL
2'-0
10'-0
CLOSE EXISTING DOOR OPENING WITH 8" OF RE-USED BRICK. SEE NOTE ON SITE PLAN AND DETAIL 5 2|2
EXISTING FOUNDATION
ETAIL 3 2|2
Y OPENING BE JOB CTOR PRIOR WOOD OWS.
SOUTH ELEVATION
SCALE: 1/4" = 1'-0
GRAPHIC SCALES
1/8" = 1'-0
1/4" = 1'-0
3" = 1'-0
3/4" = 1'-0
FOR OFFICIAL USE ONLY
STATE OF FLORIDA
HERSCHEL E. SHEPARD
#2976
REGISTERED ARCHITECT
ARCH & ENGR SEAL
SHEPARD ASSOCIATES ARCHITECTS AND PLANNERS INC. 2111 CORPORATE SQUARE BLVD JACKSONVILLE, FLORIDA / 32216
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
SOUTHERN DIVISION
CHARLESTON, S.C.
NAVAL STATION, MAYPORT, FLA.
ST JOHNS LTHSE - PHASE 2 REPRS
SITE PLAN, FLOOR PLANS, AND ELEVATION
F
80091
5080399
N62467-81-C-0060
SCALE AS NOTED
06-81-C060
SHEET 2 OF 3
NAF - BLDG 302


NEW CANOPY RIB
ORIG. COPPER SHEATHING
1"x 5/16" FLAT BAR TO BE REPLACED AT PERIMETER OF EAVES. VERIFY SIZE ON THE JOB.
ORIGINAL COPPER RAIN SPOUTS SHALL BE REFURBISHED AND SOLDERED BACK IN PLACE ON CANOPY SHEATHING
TENSION BAR
NEW CAST IRON EAVE BRACKETS MADE TO MATCH ORIGINAL SHAPE OF EXISTING RUSTED UNITS.
NEW BRASS GLAZING STOP & SPACER
NEW 5/16" FLOAT GLASS
6'-5
DOME HEAD HEX NUT
1 1/2" DIA. WASHER
1 1/2"x 1/2" GALV. STEEL RAILING
1 1/2" DIA.
NEW 1"x 2 1/2" VERT. SUPPORT MEMBERS
NEW GALV. CAST IRON STANCHIONS ANCHORED TO ORIGINAL CAST IRON FLOOR PLATES
1'-6 3/8
NEW BRASS GLAZING STOP
CLEAN & RE-INSTALL ORIG. CAST IRON FLOOR PLATES & SILL MEMBERS
2 1/4" DIA.
2 1/2" DIA.
1'-8±
ANCHOR TO MATCH ORIGINAL CONST.
STUCCO ON BRICK MASONRY
SECTION THRU LANTERN GLAZING
SCALE: 3" = 1'-0
COMPRESSION RING VERIFY DIMENSIONS
5/8"Ø TIE ROD EVERY 2ND RIB TYP. OF 5
TURNBUCKLE
1/2"x 1 1/2" INTERMEDIATE BRACING
11 1/2" DIA. CAST IRON TENSION RING 5/8"x 1" IN SECTION
5/8"x 1" TENSION BAR, TYP. OF 10
NOTE:
ALL CANOPY FRAMING MEMBERS SHALL BE NEW GALV. CAST IRON CONSTRUCTED TO MATCH ORIGINAL MEMBERS.
ISOMETRIC OF CANOPY FRAMING
SCALE: 1 1/2" = 1'-0
SEALANT OR NEOPRENE GASKET
NEW 5/16" FLOAT GLASS
NEW 1/8" THICK BR
EXTERIOR GLAZIN
RE-USE
MEMBER
NEW 1"x 2 1/2" CAST IRON VERT. MULL
RE-USE EXISTING SILL MEMBERS
LANTERN GLASS MULL
FULL SIZE


REVISIONS
LET
DESCRIPTION
PREP'D BY
DATE
APPROVED
DRWG. CORRECTED TO AS-BUILT
TURNER
ORIGINAL COPPER VENTILATOR TO BE CLEANED, REPAIRED AND REINSTALLED. DENTS SHALL BE HAMMERED SMOOTH AND ANY HOLES SEALED WITH SOLDER.
NEW METAL CANOPY FRAMING COVERED WITH ORIGINAL COPPER SHEATHING. CLEAN, PATCH, REPAIR, RESOLDER, & REWORK ENTIRE EXISTING CANOPY, VENTILATOR AND ALL ASSOCIATED ACCESSORIES TO LIKE NEW WEATHERPROOF CONDITION. REPLACE MISSING SECTIONS AND ACCESSORIES AND DAMAGED SECTIONS THAT CANNOT BE REPAIRED TO LIKE NEW CONDITION. RESOLDER JOINTS AND REPAIR ALL HOLES. SEE SPECS.
NEW 1"x 2½" VERTICAL SUPPORT MEMBERS
INSTALL ¼" CLEAR FLOAT GLASS ALL AROUND. SEE DETAILS 3/3|3 & 4/3|3
4'-6 ±
2'-9¾
3¼"
4'-0
6'-5
±7'-1½
2'-6
1'-6
4"
NEW CAST IRON STANCHIONS TO SUPPORT NEW GALV. STEEL RAILING
CLEAN & RE-INSTALL ORIGINAL CAST IRON FLOOR PLATES AND SILL MEMBERS. SEE 3/3|3
REPLACE BRICK MASONRY FORMERLY REMOVED FROM TOP OF WALL.
PATCH & REPAIR AREAS OF LOOSE OR DAMAGED MASONRY. POINT CRACKED MORTAR JOINTS. PATCH & REPAIR STUCCO TO LIKE NEW CONDITION & PAINT.
REMOVE ANY LOOSE MORTAR AND POINT ALL VOIDS & CRACKS IN MORTAR JOINTS ABOVE SLATE FLOOR
NEW GALV. STEEL HANDRAIL AND STANCHIONS. REMOVE EXISTING UNITS AND TURN OVER TO THE NAVY. STANCHIONS ARE 1"x 1" SQ. RAILING IS 1½"x ¾"
± 3'-9 RADIUS
EXISTING METAL COLLAR
EXISTING SLATE FLOOR
EXISTING CENTRAL BRICK COLUMN
EXTERIOR PORTION OF EXISTING SLATE PLATFORM SHALL BE PATCHED AND REPAIRED WITH A CEMENTITIOUS MATERIAL COLOR TINTED TO MATCH COLOR OF SLATE. THREADED INSERTS, TO RECEIVE GALV. ⅜"Ø BOLTS, SHALL BE INSTALLED TO ANCHOR NEW GALV. STEEL HANDRAIL.
NOTE:
MATERIAL FOR PATCHING SLATE SHALL BE "THORITE" MIXED WITH ONE PART ACRYL 60 TO ONE PART WATER. ¼" Ø STEEL RODS SHALL BE DRILLED INTO EXISTING SLATE AT DAMAGED AREA AND SET IN EPOXY. ENDS OF PENCIL RODS SHALL BE BENT TO PARALLEL EDGE OF PLATFORM ALLOWING A MIN. CLEARANCE OF 1". PATCHING MATERIAL EQUIVALENT IN PERFORMANCE TO "THORITE" AND ACRYL 60 MAY BE SUBSTITUTED.
SECTION THRU UPPER LIGHTHOUSE 1/2|3
SCALE: ¾"= 1'-0
IPRESSION RING
IFY DIMENSIONS
D RIB
KLE
½"x 1½" CANOPY RIBS, TYP. OF 10
"x 1½" INTER-EDIATE BRACING
⅝"x 1" TENSION AR, TYP. OF 10
1½"x 2¼ ANGLE
NEW 1"x 2½" VERTICAL SUPPORT MEMBERS TYPICAL OF TEN
FRAMING 2/3|3
NEW ⅛" THICK BRASS EXTERIOR GLAZING STOP
RE-USE EXISTING BRASS MEMBERS STORED AT SITE
MEMBERS
SS MULL 4/3|3
GRAPHIC SCALES
¾"= 1'-0
1½"= 1'-0
3"= 1'-0
STATE OF FLORIDA
HERSCHEL E. SHEPARD
2976
REGISTERED ARCHITECT
ARCH & ENGR SEAL
RECORD DRAWING
SHEPARD ASSOCIATES ARCHITECTS AND PLANNERS INC. 2111 CORPORATE SQUARE BLVD. JACKSONVILLE, FLORIDA 32216
DSGN SMITH DR JPN CHK SMITH
SUPV SMITH CH ENGR
SUBMITTED BY
DATE 10 APR 81
FIRM MEMBER (TITLE)
SOUTHERN DIV—DESIGN DIVISION
APPROVED DATE
OFFICER IN CHARGE
APPROVED
DATE
EFD FOR COMMANDER, NAVFAC
DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
SOUTHERN DIVISION
CHARLESTON, S. C.
NAVAL STATION, MAYPORT, FLA.
ST JOHNS LTHSE - PHASE 2 REPRS
SECTIONS & DETAILS
SIZE F
CODE IDENT NO. 80091
NAVFAC DRAWING NO. 5080400
SCALE AS NOTED
SHEET 3 OF 3
NAS-BLDG. 302

Appendix C: Sample Specifications

These sample specifications were taken from: Don K. Kermath, et al., *Master Specification Plan*, Draft Technical Report (TR) (U.S. Army Construction Engineering Research Laboratories [USACERL], August 1994).

Section 04100 – Mortar and Masonry Grout Repair
Section 04500 – Masonry Restoration and Cleaning
Section 05020 – Metals Restoration and Cleaning
Section 08615 – Wood Window Repair and Rehabilitation

SECTION 04100 - *MORTAR AND MASONRY GROUT REPAIR*

1 GENERAL

1.1 SUMMARY

1.1.1 Description. This section includes requirements for repair of damaged masonry joints, and patching of cracks in brick masonry.

1.1.2 Related Sections

04500 - *MASONRY RESTORATION AND CLEANING*

1.2 REFERENCES. Publications listed below form a part of this specification to the extent referenced. Publications are referred to in text by their basic designation only.

1.2.1 ASTM, American Society for Testing and Materials Publications

C144-81; Aggregate for Masonry Mortar
C150-84 Rev. A; Portland Cement
C207-79 R 1984; Hydrated Lime for Masonry Purposes

1.3 SYSTEM DESCRIPTION

1.3.1 Performance Requirements

1.3.1.a New Mortar
(1) New mortar shall match material properties of original mortar.
(2) New mortar shall match surface texture and color of original mortar.

1.4 SUBMITTALS

1.4.1 Procedures. Written procedures describing methods to use for repointing masonry mortar joints, shall be submitted for approval.
1.4.2 Mortar Samples
1.4.2.a Mortar samples of mixes to be used shall be submitted to Contracting Officer's Representative for approval prior to start of Work.
1.4.2.b The mortar samples shall be composed of actual products in exact proportions that will be used in completed project.
1.4.2.c Exact description of the mix represented by each sample shall be included with each sample.
1.4.2.d Contracting Officer's Representative shall determine which sample best meets the performance requirements of this specification.
1.4.2.e Contracting Officer's Representative may require the submittal of additional samples to obtain better compliance to performance requirements of this specification.

1.5 QUALITY ASSURANCE

1.5.1 Qualifications of Personnel. Work shall be performed by workers experienced in this type of work.
1.5.2 Field Tests
1.5.2.a A field test shall be performed prior to start of Work to demonstrate capability to comply with performance requirements of this spec.
1.5.2.b Field tests shall be conducted in accordance with all applicable specifications.
1.5.2.c Test areas shall be in an inconspicuous location (such as rear of building).
1.5.2.d Test area shall be no less than 9 square feet.
1.5.2.e Work shall not proceed until field test is accepted by Contracting Officer's Representative.
1.5.2.f Subsequent work will be held to standard established by field test.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Handling and Storage. Cementitious materials shall be handled, stored and protected in a manner that avoids contact with soil, or contaminating material, and avoids exposure to elements.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Environmental Requirements

1.7.1.a Repointed mortar joints shall be protected from direct exposure to wind and sun for 48 hours following completion of work performed when ambient air temperature exceeds 90 degrees F., in the shade, and relative humidity is less than 50 percent.

1.7.1.b Repointing work shall not be performed when ambient air temperature is less than 40 degrees F., unless area being repointed can be maintained above 40 degrees F by artificial means.

2 PRODUCTS

2.1 MATERIALS

2.1.1 Portland Cement. ASTM C150

2.1.2 Hydrated Lime. ASTM C207, Type S

2.1.3 Sand. ASTM C144. Sand shall be river or natural sand of the same texture and color of sand used in original/existing historic mortar.

2.1.4 Water. Shall be clean and free of deleterious acids, alkalies, or organic materials.

2.1.5 Coloring Pigments. When necessary to use coloring pigments they shall be pure mineral oxides which are alkali-proof and sun-fast to prevent leaching and fading.

2.1.6 Additives

2.1.6.a Additives shall not be used without consent of Contracting Officer's Representative.

2.1.6.b Chemical additives which alter freezing point or workability of mortar mix shall not be used.

2.2 MORTAR MIX

2.2.1 Components. The following formulation for mortar mix shall be used for all areas unless specified otherwise.

(a) 1 part white portland cement
(b) 3-4 parts hydrated lime
(c) 8-12 parts river sand

3 EXECUTION

3.1 PREPARATION

3.1.1 Mortar Preparation

3.1.1.a Mortar shall be carefully mixed to obtain uniformity of visual and physical characteristics.

3.1.1.b Dry ingredients shall be measured by volume and thoroughly mixed before the addition of water.

3.1.1.c Approximately half the water shall be added initially and mixed for approximately 5 minutes. The remaining water shall be added in small portions until a mortar of desired consistency is reached. Total volume of water necessary may vary from batch to batch, depending on weather conditions.

3.1.1.d Mortar shall be used within 20 minutes of final mixing.

3.1.1.e "Re-tempering," or adding more water after a mix is prepared, is prohibited.

3.1.2 Loose and Deteriorated Mortar

3.1.2.a Mortar joints shall be cleaned of all loose and deteriorated mortar to a minimum depth of 1 inch or 2.5 times gap of joint, which ever is greater. Increase depth as necessary to reach sound backing.

3.1.2.b Care shall be taken not to damage edges and corners of adjacent masonry units.

3.1.2.c Power tools shall not be used to remove mortar except where high cement content patch mortar is present. In such cases, power tools shall only be used to cut a groove down center of the mortar joint. Hand rakes shall be used to remove old mortar remaining in contact with masonry.

3.1.2.d Contracting Officer's Representative may prohibit use of particular power tools if in the opinion of the Contracting Officer's Representative adjacent masonry is being damaged by such use.

3.1.2.e Air or water shall be used to clean mortar joints of all loose particles prior to the installation of new mortar. Water pressure shall not exceed 200 psi.

3.1.2.f All abandoned masonry anchors and conduit shall be removed to a minimum depth of 1-1/2 inches prior to repointing joint.

3.2 INSTALLATION

3.2.1 Approved Procedures. Approved written procedures shall be followed for repointing of masonry mortar joints.

3.2.2 Worn Masonry. Where masonry units having worn, rounded edges, mortar shall be recessed slightly from face of units to avoid a joint profile that appears to have a wider than actual joint width.

3.2.3 Mortar Smears. All excess mortar shall be immediately removed from masonry surfaces with burlap bags, or stiff natural bristle brushes, and water.

3.2.4 Acid Cleaning. Acid cleaning is prohibited.

3.2.5 Chimneys. When repointing or replacing the tops of chimneys, existing masonry cap shall be replaced with new cap which prevents standing water and has same configuration as original.

3.2.6 Damaged Masonry Units. All masonry units damaged in performance of Work, shall be replaced at no cost.

3.3 CLEAN-UP

3.3.1 Masonry Surfaces. Upon completion of repointing, all affected surfaces shall be cleaned of mortar daubs, dirt, stains, discoloration, and efflorescence.

3.3.2 Work Area. Work area shall be returned to state of cleanliness as it was prior to start of Work.

END OF SECTION

CONSIDERATIONS 04100 - *MORTAR AND MASONRY GROUT REPAIR*

1 **Color: Matching the color of old mortar must be done: either on site or by laboratory analysis. When examined in place, the existing mortar should be cleaned or the face scraped away to reveal the original color, undisturbed by weathering. Laboratory analysis also can determine the proper coloring and should be filed [with DEH and the SHPO]. After the new mortar is applied and set, brush the joint to expose the color which may be obscured by the cementing agent. When lime is a mix ingredient, commercial cement coloring agents must be analyzed, because they may alter the basic mortar mix characteristics. Mortar colors should be particles of stable (preferably inorganic) compounds and should never exceed 15 per cent of the cement by weight. If carbon black is used, it should not exceed 3 percent of the cement.**

Note: However historically accurate, harmful additives such as salt (for lowering the freezing point)and sugar(for retarding the set), should not be used.

2 **Composition: Where major repointing of lime-sand mortar is required, the appropriate mortar should be determined by chemical analysis of the original, or chemical and physical analysis of the bricks or stone. For smaller projects, a variation of**

traditional recipes may be prescribed, although use of an untested material should be limited to areas where an adverse affect will not compromise the historic character of the structure. A small portion of Portland Cement may be added to increase strength and durability, but this ingredient should never exceed 1/12 of the total lime-sand mixture. *[In addition to having questionable strength, mortars containing Portland Cement, may act as a moisture barrier which can cause damage to adjacent masonry.]*

3 **In repointing, a good hydrated lime should be used with a clean and sharp sand as much as possible. It may be necessary to use rounded sand to approximate the color and texture of the historic mortar as many older mortars are composed of rounded river sand. In any event, the coarseness, color, and type of new sand should match the original. That match can be determined either by laboratory analysis or by crushing a sample of the original mortar, mixing it with water, and retrieving the sand residue. *[See The Repointing of Historic Masonry Buildings, Robert C. Mack and James S. Askins, Altoona: Sermac Inc., 1975, pp 9, 13,15-20.]* Take care to identify the original mortar rather than the re-pointing mortar or the overcoat of plaster or stucco.**

4 **Joints: Any renovation work involving mortar should attempt to duplicate the characteristics of the original mortar and joint unless it can be proven that the original was a poor choice, or that conditions have altered significantly since original construction. Appearance and performance are more important than duplication of constituent elements, and it is possible to match mortar visually without matching its chemical makeup. Mismatched pointing is visually disruptive.**

Good mortar joints should: 1) Bind masonry units; 2) Seal the wall from weathering forces; 3) Compensate for dimensional variation of units; 4) Absorb *[Allow]* minor wall movement; and 5) Provide a decorative effect to the wall surface.

5 **Helpful literature for individuals writing technical specifications for repointing include:**

Preservation Brief 2: <u>Repointing Mortar Joints in Historic Brick Buildings.</u>

Illinois Preservation Series: Number 10 <u>Masonry Repointing of Twentieth-Century Buildings.</u>

"Masonry Repointing," <u>The Old House Journal</u>, Vol. VII, No. 6 June 1979), pp. 61, 66-68.

"An Introduction to Repointing," APT Bulletin, Vol. XI, No. 3, pp. 44-59.

The Repointing of Historic Masonry Buildings, Robert C. Mack and James S. Askins, Altoona: Sermac Inc., 1975, pp. 9, 13, 15-20.

"The Use of Pneumatic Tools in Repointing Historic Masonry" APT Communique Vol. XV, No. 1, 1974, pp. 9-39.

END OF CONSIDERATIONS

SUGGESTED PROCEDURE 04100 - *MORTAR AND MASONRY GROUT REPAIR*

PROCEDURE FOR REPOINTING MASONRY MORTAR JOINTS

1 Wet existing masonry but not to the extent that excess standing water is present.

2 Pack mortar tightly into joints in 1/4 inch layers (wait until each layer is thumbprint hard before applying succeeding layers).

3 Match the joint to the tooling technique of the existing masonry with respect to configuration, depth, and uniformity.

4 Slightly brush the joint with a stiff natural bristle brush after completion (to give the joint a weathered appearance) and expose the aggregate to the extent that it matches adjacent existing construction.

5 Take care to avoid mortar smears and remove them as soon as they occur.

SECTION 04500 - *MASONRY RESTORATION AND CLEANING*

1 GENERAL

1.1 SUMMARY

1.1.1 Description. This section includes requirements for water, steam, and chemical cleaning of brick, stone (rubble and ashlar), marble, and terra cotta surfaces. Repair and restoration of damaged masonry.

1.1.2 Related Sections

Section 03700 - *CONCRETE RESTORATION AND CLEANING*
Section 04100 - *MORTAR AND MASONRY GROUT*
Section 09900 - *PAINTING*

1.2 SYSTEM DESCRIPTION

1.2.1 Performance

1.2.1.a Cleaned Masonry Surface.

(1) Cleaned masonry hall match surface color of clean adjacent area.

(2) Cleaned masonry surface shall be uniformly clean in all directions.

(3) Cleaned masonry surface shall not exhibit marks caused by overlap of cleaning process.

1.3 SUBMITTALS

1.3.1 Procedures. Written procedures describing methods to use for cleaning masonry surfaces shall be submitted for approval.

1.3.2 Manufacturer's Instructions. Manufacturer's instructions for application of cleaning materials shall be submitted for information only, prior to start of Work.

1.3.3 Product Data. Product data on cleaning compounds, and/or solutions, shall be submitted for information only, prior to start of work.

1.3.4 Special Details. Shop drawings shall be submitted for information only, prior to start of work. Details shall indicate, [setting details of [cut] [ ] stone], [details of special [brick] [ ] shapes], and [special supports for work] [ ].

1.4 QUALITY ASSURANCE

1.4.1 Qualification of Workers. Work shall be performed by personnel experienced in this type of work.

1.4.2 Demonstration Field Test

1.4.2.a A field test shall be performed prior to start of Work to demonstrate capability to comply with performance requirements of this spec.

1.4.2.b Field test shall be conducted in accordance with all applicable specifications.

1.4.2.c Test shall be in accordance with approved written procedures.

1.4.2.d Test area shall be the larger of 1 square yard or several masonry units including mortar joints.

1.4.2.e Test area shall be at an inconspicuous location and be representative of overall structure.

1.4.2.f Work shall not proceed until field test is accepted by Contracting Officer's Representative.

1.4.2.g Subsequent work will be held to standard established by field test.

1.4.2.h The accepted sample may remain as part of Work.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Temperature. Work shall be performed only when ambient air temperature is expected to remain above [40] degrees F for at least 7 days after completion of cleaning.

1.6 SEQUENCING AND SCHEDULING

1.6.1 Scheduling of Work. Cleaning or washing of exterior masonry shall be done between [ ] am and [ ] pm.

2 PRODUCTS

2.1 MATERIALS

2.1.1 Acceptable Cleaning Materials

2.1.1.a Cleaning Agent 1: 9 parts of sodium salt of ethylene diamine tetra-acetic acid 37.2 g/l of water, 1 part buffer solution of pH 10 (70 g ammonium chloride, dissolved in 50 ml concentrated ammonia, and water added to make volume 1 liter), and sufficient absorbent powder to make a paste.

2.1.1.b Cleaning Agent 2: Ammonia chloride and talcum in ratio of 1:4, mixed and stirred into a paste with ammonia.

2.1.1.c Cleaning Agent 3: Oxalic acid (1 part to 10 parts of water by weight).

2.1.1.d Cleaning Agent 4: Glycerine, sodium citrate, and warm water, in proportions of 7:1:6. Add an inert filler to make a paste.

2.1.1.e Cleaning Agent 5: 3 oz. trisodium phosphate (TSP), 1 oz. detergent, 1 qt. 5% sodium hypochlorite (bleach), and 3 qt. warm water.

2.1.2 Water Repellents. Use of water repellents is prohibited except for deteriorating brick that had previously been sandblasted.

3 EXECUTION

3.1 EXAMINATION

3.1.1 Condition Verification. Verify that surfaces to be cleaned are ready to receive work.

3.2 PREPARATION

3.2.1 Protection

3.2.1.a Weatherproof partitions shall be constructed to close off occupied areas from Work.

3.2.2 Removal and Storage
3.2.2.a Fixtures, fittings, finishing hardware, and other accessories that may be damaged as a result of Work shall be removed prior to commencement of any work.
3.2.2.b Items temporarily removed shall be stored in a manner to insure their protection.
3.2.2.c Reinstall items temporarily removed upon completion of Work and prior to final acceptance.

3.3 CLEANING EXISTING MASONRY

3.3.1 Approved Procedures. Approved written procedures shall be followed for cleaning of masonry surfaces. Technique: The cleaning technique shall be same as that used in field test. Moderate Pressure Steam Cleaning.
3.3.1.a Steam shall be applied at 200 - 800 psi pressure to masonry surfaces.
3.3.1.b Clean masonry surfaces shall be hand washed with detergent in accordance with manufacturer's instructions.
3.3.2 Chemical Cleaning.
3.3.2.a Previously applied coatings, such as paint, shall be removed from masonry surfaces.
3.3.2.b All chemical cleaners shall be applied with moderate pressure (200-800 psi).
3.3.2.c All residue of dirt and chemical cleaners shall be rinsed from bottom up with potable water applied between 400-600 psi at a rate of approximately 4 gal/min.
3.3.3 Permissible Applications of Chemical Cleaners (see Paragraph 2.1.1)
3.3.3.a Cleaning Agent 1 may be used for copper and bronze stains.
3.3.3.b Cleaning Agent 2 may be used on stains from copper compounds.
3.3.3.c Cleaning Agent 3 may be used for rust or iron stains.
3.3.3.d Cleaning Agent 4 may be used for rust or iron stains.
3.3.3.e Cleaning Agent 5 may be used for tar or bitumen provided masonry surface is not susceptible to damage.

3.4 DISPOSAL

3.4.1 Runoff. Runoff from cleaning operations shall be disposed of by legal means.

END OF SECTION

CONSIDERATIONS 04500 - *MASONRY RESTORATION AND CLEANING*

1 Potential harm to building materials can result from a cleaning process. It is important to consider this before selecting and initiating a cleaning process.

2 It is generally better to repaint than to remove paint. If a proposed cleaning is to remove paint from brick, research whether exposing the brick is historically appropriate.

3 Research to determine if previous treatments have been applied to the building or its surroundings, that might make cleaning difficult (i.e., waterproofing).

4 Before initiating a cleaning process, correct recurring maintenance problems caused by such things as faulty construction, hidden alterations, or previous attempts to solve moisture problems.

5 Use the gentlest means possible to remove dirt and stains. It is generally preferable to under-clean masonry, as a strong a cleaning procedure may damage the outer layer of masonry and leave it susceptible to accelerated weathering and environmental pollutants.

6 Moderate pressure steam cleaning is generally recommended for glazed and low absorptive type of masonry. Where serious staining has developed, it is sometimes necessary to use a cleaning detergent.

7 If possible, allow field test patch(s) to weather for a period of time, preferably through a complete seasonal cycle, to determine that the cleaned area will not be adversely affected by wet or freezing weather or any by-products of the cleaning process.)

END OF CONSIDERATIONS

SUGGESTED PROCEDURES 04500 - *MASONRY RESTORATION AND CLEANING*

SUGGESTED CLEANING PROCEDURES ON EXISTING MASONRY STRUCTURES

1 Procedure for Cleaning Tar or Bitumen (*** Note: The following is generally recommended for glazed and low absorptive type of masonry. Where serious staining has developed, it may be necessary to use a cleaning detergent.)

1.1 Remove excess tar [bitumen] with wood scraper.

1.2 Scrub with water and Cleaning Agent 5 (see Section 04500, Article 2.1.1).

1.3 Sponge dry or poultice with paraffin.

2 Procedure for Removing Efflorescence

2.1 Scrub off efflorescence with a dry, medium soft, non-ferrous brush.

2.2 Follow with a clear water wash and a stiff brush if necessary.

3 Procedure for Removing Moss or Organic Growth.

3.1 Wet wall with clear, potable water.

3.2 Apply weed killer according to manufacturer's recommendations.

4 Procedure for Application of Water Repellents

4.1 Repoint loose mortar joints and repair brick as needed (see Section 04100).

4.2 Remove efflorescence, organic growth, mildew and/or surface dirt.

4.3 Apply a solvent-based sealer in 2 flood coats with a 12-in. rundown, or manufacturer's recommended application rate.

SECTION 05020 - *METALS RESTORATION AND CLEANING*

1 GENERAL

1.1 SUMMARY

1.1.1 Description. This section specifies requirements for repair and cleaning of the following metals: cast and wrought iron, copper, steel, tinplate, terneplate, lead, zinc, galvanized iron and steel, and aluminum.

1.1.2 Related Sections

07610 - *SHEET METAL ROOFING REPAIR*
07620 - *SHEET METAL FLASHING AND TRIM*
09900 - *PAINTING*

1.2 SYSTEM DESCRIPTION

1.2.1 Performance Requirements

1.2.1.a Metal Cleaning. Unpainted cleaned metal surfaces shall match surface color of adjacent unpainted cleaned metal surfaces.

1.2.1.b Metal Repairs. Surface of repairs shall blend into adjacent metal surfaces.

1.3 SUBMITTALS

1.3.1 Procedures. Written procedures for the following items shall be submitted for approval as applicable.

1.3.1.a Methods of cleaning

1.3.1.b Preheating for arc welding

1.3.1.c Post weld heat treatment

1.3.1.d Cold metal stitching

1.3.1.e Repair of cast iron fractures

1.3.2 Product Data. Manufacturer's product specifications and installation instructions shall be submitted for each product for information.

1.4 QUALITY ASSURANCE

1.4.1 Qualifications of Personnel. Work shall be performed by personnel experienced in this type of work.

1.4.2 Samples. Samples shall be submitted for each type of repair to be done prior to start of Work.

1.4.3 Demonstration Field Tests

1.4.3.a A field cleaning test shall be performed prior to start of Work to demonstrate capability to comply with performance requirements of this spec.

1.4.3.b Tests of abrasive cleaning methods shall be conducted to determine appropriate air or water pressure and grit size for each type of material to be cleaned abrasively.

1.4.3.c Field test shall be conducted in accordance with all applicable specifications.

1.4.3.d Test area shall be in an inconspicuous location.

1.4.3.e Work shall not proceed until field test is accepted by Contracting Officer's Representative.

1.4.3.f Subsequent work will be held to the standard established by the field test.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Original Packaging. Materials shall be delivered in original packages, containers, or bundles bearing brand name and identification of manufacturer.

1.5.2 Storage. Materials shall be stored inside, under cover, and in manner to keep them dry, protected from weather, direct sunlight, surface contamination, aging, corrosion, and damage from construction traffic and other causes.

2 PRODUCTS

2.1 MATERIALS

2.1.1 Patching Material for Steel. Material used to patch steel shall contain steel fibers in epoxy binder.
2.1.2 Properties of Caulk
2.1.2.a High tolerance for material movement.
2.1.2.b Resistant to ultraviolet light.
2.1.2.c 10 years minimum durability.
2.1.3 Sealant. Architectural-grade silicone-rubber sealant.
2.1.4 Composition of Solder
2.1.4.a ASTM B32
2.1.4.b Solder used on zinc shall be free of antimony.
2.1.5 Flux
2.1.5.a Rosin flux shall be used in conjunction with tinplate, terneplate and copper.
2.1.5.b Acid flux shall be used in conjunction with zinc, nickel, and Monel.
2.1.6 Fasteners. Fasteners shall be galvanically compatible with the metals to which they attach.
2.1.7 Rust Inhibitors. The concentration of rust inhibitors shall not exceed 5000 parts per million.
2.1.8 Prohibited Products
2.1.8.a Abrasive cleaners with coarse abrasives shall not be used on aluminum.
2.1.8.b Vinegar shall not be used on galvanized metal.

2.2 TOOLS AND EQUIPMENT

2.2.1 Blasting Nozzles
2.2.1.a Nozzles used in wet service shall have independent control over air, water, and abrasive.
2.2.1.b Nozzles used in dry service shall have pencil points.
2.2.2 Wire Brushes. Wire brushes shall not be used to clean lead.

3 EXECUTION

3.1 PREPARATION

3.1.1 Cleaning Requirements
3.1.1.a The gentlest effective cleaning method, or combination of methods, shall be determined and used.
3.1.1.b Surfaces cleaned with alkaline cleaners shall be neutralized to pH 7.
3.1.1.c Cleaned surfaces shall have no harmful corrosion products.
3.1.1.d All soluble corrosion salts shall be removed from iron and iron alloys before priming.
3.1.1.e Cleaned iron and iron alloys shall be coated with paint or other protective coatings.

3.1.1.f Surface detail shall not be scored or marred in the cleaning process.
3.1.2 Prohibitions
3.1.2.a Rivets and bolts shall not be replaced with welded details.
3.1.2.b Welding shall not be performed within 3 inches of rivets and bolts.
3.1.2.c Soldering shall not be performed on lead or aluminum.
3.1.2.d Finely detailed wrought iron shall not be cleaned using abrasive methods.

3.2 PROTECTION OF ADJACENT AREAS. Adjacent areas and surfaces shall be protected with plywood barriers while abrasive cleaning is in process.

3.3 INSTALLATION: CLEANING (See Section - 09900 Painting)

3.3.1 General
3.3.1.a Bare metal surfaces shall be cleaned immediately before application of primer.
3.3.1.b Sound layers of paint shall not be removed. Feather edges of paint to provide smooth finish.
3.3.1.c Metal surfaces (except galvanized iron or steel) shall be cleaned with cold phosphoric acid, denatured alcohol, or mineral spirits prior to painting.
3.3.1.d Surfaces of galvanized iron or steel shall be cleaned with paint thinner or mineral spirits prior to painting.
3.3.2 Abrasive Cleaning
3.3.2.a Iron and Iron Alloys. Light rust may be removed from Iron and Iron Alloys using aluminum oxide sandpaper, wire brush, or electric drill with special wire brush or rotary whip attachment.
3.3.2.b Cast Iron. Heavy rust may be abrasively removed from cast iron by sandblasting at low-pressure (less then 100 psi) with #10-#45 sized grit and a pencil point nozzle for control.
3.3.2.c Wrought Iron. Wrought iron may be abrasively cleaned to remove rust at low-pressure (less than 70 psi) using fine sized grit such as copper slag.
3.3.2.d Steel. Steel may be cleaned abrasively to remove heavy corrosion using low-pressure (100 psi) blasting with #10-#45 sized size or glass pellets, and pencil point blaster.

3.3.3 Flame Cleaning. Wrought iron may be flame cleaned to remove rust and loose mill scale with oxyacetylene or oxypropane flame. Do not use flame cleaning on elements that cannot be removed from structure.

3.4 INSTALLATION: REPAIR

3.4.1 Galvanic Compatibility. Metals must be galvanically compatible, or must be separated from direct contact by rubber gaskets.
3.4.2 Iron or Bronze Casting Repair. Fractures on cast metal thicker than 1/4 inch shall be repaired with a cold metal stitching system.
3.4.3 Water Traps. Small holes and water traps in ferrous materials shall be filled with plumbing epoxy or auto body epoxy.

3.4.4 Wrought Iron Repair. Scarf and rivet new sections into position.
3.4.5 Lead Repair. Repair fractures and breaks by lead burning.
3.4.6 Aluminum Repair. Aluminum may be repaired by brazing, inert-gas-shielded arc welding processes, adhesive bonding, bolting, or riveting.

3.5 CLEAN-UP

3.5.1 Affected Surfaces. Upon completion of repair, clean all affected surfaces of debris.
3.5.2 Work Area. Work area shall be returned to state of cleanliness that existed prior to start of Work.

END OF SECTION

CONSIDERATIONS 05020 - *METALS RESTORATION AND CLEANING*

4 <u>PRIMARY ISSUES IN METALS RESTORATION AND CLEANING</u>

4.1 Structural Considerations

4.1.1 Always consult a structural engineer whenever questions regarding structural integrity arise.
4.1.2 Differential settlement can introduce torque and change loading patterns. If the building has reached equilibrium and the members are not stressed beyond their capacity, the best option may be to leave it alone.
4.1.3 New uses of existing buildings may increase loads, requiring structural modifications.

4.2 Connections

4.2.1 Corners and Edges. When repairing, avoid introducing details that can catch and hold water, especially for iron and steel construction. If such historical details must be kept, clean periodically and protect against oxidation. Modify sharp corners and edges; rounded contours prevent mechanical damage to metal and breakdown of protective coverings.
4.2.2 Architectural Cast Iron. Most Architectural cast iron is assembled with bolts or screws. These connections were caulked to prevent water seepage. Once the caulk deteriorates or is destroyed by settlement or sandblasting, it must be replaced to prevent corrosion.
4.2.3 Connection Failures. Connection failures can be caused by a combination of physical or chemical agents. This is mostly a structural problem, but not exclusively. Bolting, riveting, pinning and welding can fail through overloading, fatigue, or corrosion. When connectors corrode, the reduced

effective cross-sectional area makes connectors more susceptible to stress failure.

4.3 Surfaces/Finishes:

4.3.1 Protective Coatings. Paint is the most common protective coating to prevent corrosion. Other coatings include porcelain enamel or plating with other metals. Use of these coatings are appropriate only where they were historically used. The integrity of the coating is essential to prevent corrosion. Metals that need protective coatings on exposed surfaces, such as terne or steel, also need protective coatings on sheltered surfaces, like on the underside of eaves where moisture evaporation is inhibited. Many sheltered surfaces were originally left unprotected.

4.3.2 Zinc Coatings. The major advantage of zinc coatings on iron is that if the zinc wears away or breaks off and the iron becomes exposed to the atmosphere, then galvanic corrosion of the base zinc occurs, protecting the more noble iron.

4.4 Condition Assessment and Documentation/Testing. A qualified professional such as a preservation architect or a building conservator with experience in metals should document the existing condition of the metal elements with drawings, photos, and written descriptions, identify the problems of repair, and provide a detailed listing of recommended work items with priorities. Through this process, the significance and condition of the metals can be evaluated and appropriate treatments proposed. For the repair work, minor problems such as surface corrosion, flaking paint, or failed caulking can be repaired by a knowledgeable contractor. Major problems should be handled by an experienced preservation architect.

4.5 Identification. Often, painted metals can be difficult to identify. Many silvery-white metals are challenging to distinguish without expert testing. Use original specifications, correspondence, or consult a preservation consultant or historical architect. A professional, such as a chemist, metallurgist, metal conservator, or corrosion engineer can identify metals. Pure zinc is often mistaken for tin-plated or galvanized sheet iron. They can easily be distinguished because zinc is non-magnetic and iron is magnetic. However, most stainless steel is non-magnetic, except low quality stainless with high percentages of carbon.

5 PRIMARY CAUSES OF FAILURES

5.1 **Improper or Poor Craftsmanship.** Mechanical defects in manufacturing of cast iron, such as air-holes, cold shuts (imperfections caused by the "freezing" of the surface of the molten iron during casting due to improper or interrupted pouring), cracks and cinders, can greatly reduce the mechanical strength of an architectural member. A number of nondestructive tests using, for example, fluorescent fluids and ultraviolet lamps, have been developed to detect these potential defects.

5.2 **Galvanic Incompatibility.** Rust or corrosion may be caused by galvanic incompatibility with an adjacent metal. This is an electrochemical action that results when two dissimilar metals react together in the presence of an electrolyte, such as water containing salts or hydrogen ions. All metals range on a scale from most noble, or electronegative, to least noble, or electropositive. Two metals near each other on the scale will be galvanically compatible, and may be used in conjunction with each other without causing corrosion. Two metals from opposite ends of the scale are not compatible, and the least noble one will corrode. The severity of the corrosion also depends on the metals relative surface area, and time. A large amount of a more noble metal next to a small amount of base metal will cause the base metal to corrode rapidly and severely. The following list of metals, and metal alloys, is in decreasing order of nobility.

5.2.0.a Mercury
5.2.0.b Vanadium
5.2.0.c Gold
5.2.0.d Silver
5.2.0.e Nickel
5.2.0.f Copper
5.2.0.g Brass
5.2.0.h Manganese Bronze
5.2.0.i Stainless Steel
5.2.0.j Wrought Iron
5.2.0.k Tin
5.2.0.l Silver-Lead Solder
5.2.0.m Chrome Plate (on steel)
5.2.0.n Lead
5.2.0.o Tin Electroplate
5.2.0.p Cast Iron
5.2.0.q Mild Steel
5.2.0.r Non-Stainless Steel
5.2.0.s Aluminum
5.2.0.t Zinc

5.2.0.u	Cadmium-Zinc Solder
5.2.0.v	Zinc Electroplate
5.2.0.w	Galvanized (Hot Dipped) (on steel)
5.2.0.x	Magnesium

5.3 Improper Treatments or Maintenance

5.3.1 Improper Copper Repairs. Filling stress cracks in copper using soldered patches or soft solder will eventually fail due to differential thermal expansion caused by different coefficients of thermal expansion. Such a procedure may be adequate as an interim measure, but the copper will eventually have to be replaced. Since solder is inherently weak, it should only be used to create watertight joints, not where tensile or compressive strength is needed. Patches on copper sheets weighing 16 oz. or less may be soldered. Where tensile or compressive strength is needed, and when patching with sheets thicker than 20 oz., they should be connected with copper rivets, or copper clips and tabs held with copper nails depending on the size of the patch.

5.3.2 Using asphaltic roofing compounds (elastic cement) to repair sheet metal. Black roofing cement causes many problems. Some products corrode metal, many do not hold up well in ultraviolet light, and especially in gutter linings, several become brittle with repeated freezing. Roofing cement is almost impossible to remove, making the damaged metal unsalvageable.

5.3.3 Filling Voids in Cast Iron with Concrete. Voids in cast iron elements exposed to rainwater should not be filled with concrete. The shrinkage of concrete during curing can leave a crevice which can retain water, offering prime conditions for rusting and giving the swelling rust a surface to push against.

5.4 Deleterious Chemical Environments

5.4.1 Iron and Iron Alloys

5.4.1.a Iron is subject to corrosion and rust if it is not kept clean, or protected by an intact cover of paint. Cast iron rusts rapidly when exposed to moisture and air. The relative humidity need only be 65% for rust to start, and this number is even lower when the metal is in the presence of corrosive agents such as sea water, salt air, acids, acid precipitation, soils, gypsum plasters, magnesium oxychloride cements, ashes and clinkers, or some sulfur compounds present in the atmosphere. When salts are present, they act as electrolytes, accelerating the corrosion of iron and steel and making it more complicated. Rust is also accelerated in architectural details which trap water in pockets or crevices. Once a rust film occurs, its porosity acts as a reservoir for any liquid present, which also tends to accelerate corrosion.

5.4.1.b As iron rusts, it expands. The resultant pressure damages surrounding materials such as concrete or terra cotta, causing cracks and spalling.

5.4.1.c If rusting is merely a surface accumulation or flaking, then corrosion is light. If rusting has penetrated metal (indicated by a bubbling texture), but has not caused any structural damage, corrosion is medium. If rusting has penetrated deep into the metal, corrosion is heavy. Heavy corrosion usually results in some sort of structural damage, through delamination, to the metal section, and is identified when a sharp probe (ice pick) penetrates the surface and can dig out brittle strands.

5.4.1.d Cast iron develops a kind of protective scale on its surface, thus it is slightly more resistant to corrosion than ordinary steel. However, it should be kept painted to prevent rusting. Graphitization of cast iron occasionally occurs in the presence of acid rain or sea water. This is the impregnation of the porous graphite corrosion residue with insoluble corrosion products as the iron corrodes, so that the cast-iron element retains its appearance and shape but is much weaker mechanically. It occurs occasionally where cast iron is left unpainted for long periods or where caulked joints on a cast-iron facade have failed and acidic rainwater has corroded pieces from the backside. A graphitized area can show up as a black surface which may be slightly blistered. The surface can often be broken up easily with a knife blade and the underlying material will crumble.

5.4.1.e Wrought iron generally rusts more quickly than cast iron. The corrosion can be measured more easily and the degree of deterioration ascertained. Wrought iron is resistant to progressive (severe) corrosion, primarily because of the slag content which acts as a barrier to corrosion.

5.4.1.f Steel can resist rusting, but this varies from alloy to alloy. Those alloys containing chromium, nickel, or both, are far more resistant to corrosion than other alloys. Both tests and experience have shown that high-strength low-alloy steels are more resistant to atmospheric corrosion than ordinary mild steel. Unlike cast iron, steel generally has poor resistance to corrosion from fresh water and sea water. The rate of corrosion increases as the temperature of the water surrounding a steel member rises and as the water movement accelerates.

5.4.1.g Galvanized iron and steel can resist corrosion, but this depends on the type and thickness of the protective zinc coating, the type and thickness of additional protective coatings, and the kind of corrosive environment to which it is exposed. Like most types of iron and steel, it is corroded by acids and chemical fumes.

5.4.1.h Stainless steels have a high resistance to oxidation and corrosion. Chromium and chromium nickel stainless steels resist atmospheric corrosion and corrosion from hydrogen sulfide and sulfur dioxide. Since they also have good resistance to water and to some soils, they often retain their natural finishes. A thin, oxide coating occurs readily in almost any environment containing oxygen, providing stainless steel's high corrosion resistance. When corrosion does occur, it is usually localized. As with all metals, chlorides increase susceptibility of attack, therefore, stainless steel can be lightly corroded by mortar and pitted by a salt environment.

5.4.1.i Soluble corrosion salts must be removed from the bottom of pits within an iron surface. They are not readily removed by cleaning with large-sized abrasive particles. Tests for soluble corrosion salts should be carried out on iron structures in marine and industrial environments both after cleaning and immediately prior to painting.

5.4.2 Lead

5.4.2.a Lead is stable and does not react with most common chemicals; therefore, it is highly resistant to corrosion. When exposed to air, it forms a protective patina that may be a thin, whitish film of lead oxide, or a thick, darker coat of lead sulfate, both of which usually resist corrosion. Hence, lead does not need to be painted. The resistance of lead towards a particular corrosive agent depends on the solubility of the coating formed during the initial attack: if the coating is soluble to corrosive elements in solution, corrosion will continue, while an insoluble coating will resist further attack.

5.4.2.b Exposure to alkalis, such as lime and cement mortar, results in a reddish lead oxide. Reaction with carbon dioxide and organic acids, as in damp wood, form a whitish basic carbonate or lead formate coating. Both of these permit very slow corrosion, which could take decades to severely damage most lead building materials.

5.4.2.c Lead is highly resistant to corrosion by atmospheric pollution. Sulfur fumes common in urban areas react with lead to form a sulfate layer, which protects the lead from further attack. Lead resists corrosion by many acids including chromic, sulfuric, sulfurous, and phosphoric; however, it is corroded by hydrochloric, hydrofluoric, acetic, formic, and nitric acids. Acetic acids are present in fumes given off by breweries, pickle factories, and saw mills.

5.4.2.d Lead can be corroded by atmospheric radiation which ionizes nitrogen to form oxides. The oxides in turn combine with water to form nitric acid, which attacks the lead. Lead is also attacked by carbon dioxide dissolved in ground water (a situation possible with lead used for damp-proof coursing); however, lead is stable in water containing calcium sulfate, calcium carbonate, or silicic acid. Lead resists corrosion by sea water, salt solutions, neutral solutions, and many types of soils.

5.4.3 Tin: Tin by itself is mechanically weak and is, therefore, used for coating stronger base materials.

5.4.3.a Tin and terneplatings on iron sheets are stable coatings that resist corrosion caused by oxygen, moisture, sulfur dioxide, and hydrogen sulfide.

5.4.3.b When exposed to the atmosphere, tin readily develops a thin film of stannic oxide, which helps resist corrosion. Although pure tin is mildly corroded by exposure to acids, marine atmospheres, and certain alkalis, tinplate roofing is generally very durable as long as the tin or terne coating maintains its integrity. Once the plating has been broken and the iron or steel is exposed to oxygen, the deterioration begins and is accelerated by the galvanic action between the tin and iron. The tin then acts as a cathode to the iron, which increases the corrosion of the iron at the break in the tin coating.

5.4.4 Zinc

5.4.4.a Zinc is vulnerable to corrosion by acids and strong alkalis, including sulfur acids produced by hydrogen sulfide and sulfur dioxide pollution in urban atmospheres. Zinc is also attacked by acids found in redwood, cedar, oak, and sweet chestnut, and can be corroded by plasters and cements containing chlorides and sulfates (especially Portland Cements). Water, especially acidic rainwater run-off, can also corrode.

5.4.4.b Although zinc develops a carbonate on its surface by exposure to the atmosphere and by the action of rainwater, the coating is neither dense nor adherent enough to protect the zinc from continued attack. The carbonate becomes brittle and crusty and eventually splits, exposing fresh zinc for corrosion. In industrial atmospheres, the zinc carbonate coating is broken down by the same acids that attack zinc. These acids convert the carbonate to zinc sulfate, which is water soluble and washes away with rainwater, often staining adjacent building elements.

5.4.5 Copper: Copper combines with hydrogen sulfide and oxygen or sulfur dioxide to form a protective copper carbonate or copper sulfate coating which resists further corrosion and generally does not change further in appearance. However, copper is attacked by alkalis, ammonia, and various sulfate compounds that combine with water to form sulfuric acid. Some bituminous roofing cements will attack copper.

5.4.6 Nickel: Nickel resists corrosion by salt water, strong alkalis, and most acids, except nitric acid. Nickel silver (a class of nickel alloys containing nickel, zinc, copper and small quantities of tin and lead when cast) resists corrosion, especially outdoors where it acquires a soft brown or greenish patina. Monel metal (a registered trademark name for an alloy of approximately two-thirds nickel and one-third copper) is attacked by some acids, alkalis and salts. When Monel oxidizes, it forms a silver-gray to greenish-brown protective, but unattractive, patina.

5.4.7 Aluminum: Aluminum is resistant to most types of corrosion, including sulfur compounds, other atmospheric gases, moisture and many kinds of soils. It combines readily and quickly with oxygen to form a transparent, tightly adherent film of oxide which is relatively inert to further chemical action. Corrosive agents that actively attack aluminum include alkalis, hydrochloric acid, lead-based paints, certain wood preservatives, and chlorides. Wet lime mortar, Portland cement, plaster, and concrete will cause some surface corrosion of aluminum; but once cured, they have no further corrosive effect. Aluminum is often corroded where it comes into contact with damp, porous brickwork and stonework.

5.5 Deleterious Mechanical Environment

5.5.1 Abrasion: Erosion of metal caused by moving dirt, dust, sand, grit, sleet and hail, or by rubbing with other architectural elements or people. If protective coatings are abraded through to the base metal, corrosion is encouraged. An especially critical example of abrasion damage happens to metal flashings and valleys on slate roofs. As the slate deteriorates, particles break off and are washed down the valleys, causing erosion. Soft metals, such as lead, copper and zinc are particularly vulnerable to abrasion damage.

5.5.2 Fatigue: Failure of metal by repeated cyclic loads below the elastic limit. The elastic limit is the greatest stress a material can withstand without permanent deformation after removal of a load. Lead fatigue is accelerated by irregularities in the roof sheathing and by the use of bituminous or asphaltic building paper.

5.5.3 Creep: Permanent geometric deformation of materials usually in the presence of sustained loads over time. Creep is somewhat temperature sensitive, particularly at temperatures where a material tends to loose strength. Creep is not self limiting and can propagate uncontrollably until material failure occurs. Under the influence of creep, metal components typically experience geometric deformations which lead to increased stress levels without corresponding increases in loads. Allowed to continue, the deformation will continue over time to the point where stress levels may be sufficient enough to cause failure. Sheet lead roofing and pure zinc are particularly vulnerable to creep. A smooth and evenly sheathed surface promotes creep by helping to provide free thermal movement, but minimizes fatigue.

5.5.4 Overloading: The stressing of a metal member beyond its yield point so that permanent deformation, fracturing, or failure occurs.

5.5.5 Deformation of Zinc Coatings. Flaking and peeling of the zinc coating is a problem with old, hot-dipped galvanized iron sheets. Because of the galvanizing techniques, a thick, brittle coating of zinc was formed. This coating can peel and flake when the iron sheet is deformed - that is, folding and stamping after the coating has been applied, exposing the iron sheet to corrosion.

5.5.6 Impact Damage: Soft metals, such as copper or aluminum, are vulnerable to impact damage such as by hail.

5.6 Deleterious Thermal Environment

5.6.1 Thermal Expansion/Contraction:

5.6.1.a Lead: Because lead has a relatively high coefficient of thermal expansion (three times that of steel), it is subject to buckling and fatigue cracking caused by daily and seasonal temperature changes.

5.6.1.b Zinc: Zinc has a relatively high coefficient of thermal expansion and is therefore vulnerable to fatigue failure. Thermal movement is also damaging to the carbonate coating.

5.6.2 "Tin Pest": When pure tin is heated at low temperatures for long periods of time, it deteriorates by disintegrating and crumbling to a nonmetallic gray powder. Called "tin pest" or "tin plague," this type of deterioration is usually not a problem with tinplate sheets used for architectural purposes.

5.6.3 Fire: Lead roofs can melt during a fire and sheet metal decorations can buckle from heat and fall off buildings when their anchorage is lost.

5.7 Deleterious Biological Environment

5.7.1 Lead: Ants and other insects contain formic acid, which corrodes lead. Certain beetles and squirrels have been known to eat through lead. Lead should be protected from contact with oak building members, as tannic and other acids in the wood attack the metal. Acids produced by other woods such as elm and cedar also attack lead. Lead is corroded by acidic runoff caused by mosses, lichens, and algae from slates, tiles, duckboards, or glass in skylights.

5.7.2 Copper: Copper's protective patina is corroded or prevented from forming by rainwater that has become acidic through contact with moss, lichen, algae or wood shingles. It is also attacked by sulfate reducing bacteria, which acts as a catalyst for corrosion.

5.7.3 Galvanized Iron and Steel: Galvanized steel can generally be used in direct contact with most wood, except cedar, oak, sweet chestnut, and redwood, all of which produce acids. Contact with moist wood of any species can cause an oxygen concentration cell.

5.7.4 Aluminum: Unseasoned, damp oak, cedar and redwood produce acids that will attack aluminum, even in rainwater runoff. In addition, any wet wood in direct contact with aluminum will corrode it.

6 GENERAL INFORMATION

6.1 Iron Ore is the source of all iron and steel. The iron ore is melted in a blast furnace and mixed with limestone to remove the oxygen from the ore. The resulting iron is known as pig iron, contains about 3.5% carbon, and is cast into bars from which are manufactured the various kinds of iron and steel. The amount of carbon is the element which gives each of the iron alloys its distinct characteristics. Wrought iron is the purest iron and contains between 0.02-0.035% carbon. Cast iron contains between 1.7-4.0%, (usually 3.0-3.7%). The various classifications of steel, including mild, low-carbon, and high-carbon, contain between 0.2-2.0% carbon.

6.2 Wrought iron is very malleable, easy to weld, and less susceptible to rust than cast iron or steel. Wrought iron contains 1-4% slag, in a mechanical mix with the iron (not alloyed), and this gives wrought iron its layered or fibrous structure. Cast iron is extremely brittle, highly susceptible to rust, weak in tension, and extremely strong in compression. Cast iron cannot be bent or twisted and is very difficult to weld; the pieces are usually formed in molds while the iron is molten and held together mechanically with bolts. Cast iron with flakes of carbon is called gray cast iron. This often appears on the broken edge of a cast iron piece where there may be flakes of free graphite, causing a "gray fracture" appearance. The graphite accounts for the brittleness of cast iron. This brittleness is the main characteristic which distinguishes cast iron from mild steel. Steel is stronger in tension than wrought iron, and stronger in compression than cast iron.

6.3 **Wrought iron and cast iron display several visual differences that help to identify them. Wrought iron is typically simpler in form and detail than cast iron, and less uniform in appearance. It displays evidence of rolling or hand working and is usually riveted or forge molded (heat-welded) together. Cast iron will display mold lines, flashing, casting flaws, or air holes. It is much more uniform in appearance, and tends to have more repetitive elements, which are usually bolted or screwed together.**

6.4 **What is generally called "wrought iron" today is actually mild steel that has been hand-forged using traditional blacksmithing techniques. Mild steel is now used to fabricate new hand-worked metal work and to repair old wrought iron elements. It is an alloy of iron, containing no more than 2.0% carbon. It is strong, but still easily worked in block or ingot form. Mild steel is less corrosion-resistant than either wrought or cast iron. It does not merit the same care that true wrought iron would, since it is not as rare a material. Recycled wrought iron can be re-rolled to form replacement elements, if available.**

6.5 **The required degree of cleaning varies from project to project. First, decide if cleaning is necessary to halt corrosion, or as preparation for repairs, or desired as a purely cosmetic measure. Determine whether corrosion is protective or harmful before deciding to remove it. Paint removal is covered in 09900 Painting; however, note that corrosion needs to be removed before repainting. Careful coordination of sections is required.**

6.6 **Cleaning Techniques: Choice depends on the state of deterioration, materials, texture, degree of detail, type of corrosion, staining, surrounding conditions, and the budget for labor. Experimentation will be necessary to find the gentlest effective technique for each situation. Any technique should be tested before approval.**

6.6.1 Wet abrasive cleaning methods are suitable to remove lead-based paints and to remove soluble corrosion salts. Remove excess water after cleaning, using special care on horizontal surfaces and water traps. Including rust inhibitor in the final wash to delay the need to prime for up to 24 hours.

6.6.2 Flame cleaning is considered the most appropriate cleaning method for wrought iron. However, thin sections of wrought iron (less than 0.1 inch) may warp during flame cleaning unless done with great care. Flame cleaning is a fire hazard, and if the flame is traversed too slowly, unbonded scale and other foreign matter may fuse to the surface. Do not use flame cleaning on elements that cannot be removed.

6.6.3 Do not use abrasive blasting methods on galvanized and soft metal because it is too easy to pit the surface and/or damage the zinc coating.

6.6.4 After cleaning copper, if a natural or un-patinated color is desired, a lacquer or Incralac coating will protect it.

6.6.5 Clean copper with solution of 4 oz. copper sulfate to 1 gallon lukewarm water and 1/8 oz. nitric acid to remove grease and oil from pores.

6.6.6 Lead may be Cleaned with: neutral pH soap in warm water applied with soft cloth.

6.6.7 Soak in Versene powder (tetrasodium salt of ethyl-enediaminetetra-acetic acid), Versene acid, and water. remove lead carbonate with EDTA-related product.

6.6.8 When replating tinplate or terneplate, extremely gentle methods of abrasive blasting (such as walnut shells) may be acceptable.

6.7 Cold repairs are generally preferred for non-structural cast iron instead of welding. Stainless steel or non-ferrous metals should be used whenever possible, within galvanic compatibility. Cast iron can be welded with great experience and careful supervision, but it is not always possible to be sure of the integrity of the repair. Preheating and post-weld heat treating are necessary to ensure a gradual temperature change within the metal to avoid recrystallization and cracking. Metallic bond (gas) welding uses a far lower temperature and more gradual temperature changes than fusion (arc) welding. Therefore, metallic welding is a more reliable technique than fusion welding. Welding should only be done if cold repairs are not possible. Experienced ironworkers should be consulted before deciding to do any cast iron welding, especially on structural cast iron.

6.8 If pieces of the cast iron are missing, they may be cast at a local foundry. Cast iron shrinks about 1% from melting point. Where this is acceptable, existing pieces may be used as patterns. Otherwise, a new pattern will need to be made. For an original item to be used as a pattern, it must be able to be drawn out of each side of the mold. A less historically accurate option is replacement with painted fiberglass, aluminum, epoxy, or glass fiber-reinforced concrete copies. Lighter weight aluminum or fiberglass may be necessary for structural or seismic reasons.

6.9 Welding of lead is called "leadburning." The filler material used is lead, not solder. Poor quality cast lead may have extensive gross inclusions, making leadburning impossible. In these cases, an inert epoxy-based filler must be used.

6.10 Partially deteriorated lead can be temporarily repaired with paint or a sacrificial layer of copper in localized, inconspicuous areas.

6.11 Replace stripped or rusted bolts and screws with new stainless steel bolts and screws. Larger diameter bolts or screws may be needed to replace members with enlarged holes.

6.12 When brightly colored solder joints are desired on tinplate or terneplate, specify solder with a higher percentage of tin than normal; for lead-coated copper, use 60 tin, 40 lead solder.

6.13 GALVANIZING - Common methods of applying protective coatings of zinc to iron and steel

6.13.1 Hot-Dip Galvanizing: immersion of iron or steel in molten zinc, after the surface of the iron has been properly cleaned. A relatively thick coating of zinc forms, freezing into a crystalline surface pattern, or "spangles." A multi-layered structure of iron-zinc alloys forms between the inner surface of the zinc coating and the iron. The middle layers tend to be hard and brittle, and may peel or flake if the iron element is bent. Hot-dip galvanized metal may be difficult to obtain, as currently most galvanized metal is electroplated.

6.13.2 Electrogalvanizing (Electroplating): immersion of iron or steel in an electrolyte, a solution of zinc sulfate or cyanide. Electrolytic action deposits a coating of pure zinc on the surface of the iron. The thickness of the coating can be accurately controlled, but thick coatings as from the hot-dip process are usually not possible this way.

6.13.3 Sherardizing: placing of a thoroughly cleaned iron or steel element in an air-free enclosure, surrounded by metallic zinc dust. The element is then heated and a thin, zinc alloy coating is produced, conforming to the surface configuration of the element. This process is usually limited to relatively small objects.

Metallic Spraying: application of a fine spray of molten zinc to a clean iron or steel element. The coating can then be heated and fused with the surface of the iron to produce an alloy. The coating is less brittle than those produced by some other processes and won't peel or flake on bending. But, the coating is more porous than other and becomes impermeable with time as products of corrosion fill in the pores.

6.13.4 Painting: paints with zinc dust pigments can be applied on site, but are a less effective form of zinc coating.

6.13.5 Rust Removal from Galvanized Iron and Steel. Rust may be removed from galvanized iron and steel by hand sanding, scraping, or wire brushing or by chemical stripping methods.

END OF SECTION

SUGGESTED PROCEDURES 05020 - *METAL RESTORATION AND CLEANING*

1 **Identifying and Removing Soluble Corrosion Salts on Iron and Iron Alloys.**

1.1 **Dip blotting paper in 10% solution of potassium ferricyanide.**

1.2 **Apply dried strips to dampened metal.**

1.3 **If the test strip color changes color, soluble ferrous salts are present. Remove soluble corrosion salts with wet abrasive method.**

1.4 **Blast surface using a blasting nozzle that has an independent control over air, water and abrasive.**

1.5 **Wash away all traces of dirt and grit from the surface.**

1.6 **Include a rust inhibitor (not more than 5000 ppm) in the final wash.**

1.7 **Remove all water remaining on the surfaces. Be especially careful to get water out of small holes and traps.**

1.8 **Prime immediately with water tolerant primer.**

2 **Cleaning Highly Corroded or Stained Bare Aluminum**

2.1 **Polish with a strong acid or alkaline based etching cleaner.**

2.2 **Rinse thoroughly with water.**

2.3 **(Optional) Polish with a fine pumice powder and stainless steel wool, grade 0000 to 00.**

2.4 **Wipe dry.**

2.5 **Test acidity. Neutralize to pH 7 if necessary.**

END OF SECTION

SECTION 08615 - *WOOD WINDOW REPAIR AND REHABILITATION*

1 GENERAL

1.1 DESCRIPTION: This section specifies requirements for repairing and rehabilitating wood double-hung windows, including sill and frame repair, sash repair, interior trim repair, hardware replacement, new sash balances, repair sash balances, new weatherstripping, and putty repair, and parting bead replacement.

1.2 RELATED SECTIONS

02020 Protection of Existing Conditions
06020 Wood Restoration and Cleaning
09900 Painting

1.3 SUBMITTALS

1.3.1 Product Data. Submit manufacturer's product specifications and installation instructions for each product, including data showing compliance with requirements.

1.3.2 Samples. Samples of required hardware for alternative proposals.

1.4 QUALITY ASSURANCE

1.4.1 Qualification of Workers. All work shall be performed by workers experienced in this type of work.

1.4.2 Qualification of Installer. A specialist in this type of work, employing skilled workers, and able to document similar installations functioning in satisfactory service after 3 years.

1.4.3 Field Test

1.4.3.a Select 1 wood double-hung window.

1.4.3.b Repair and rehabilitation shall be made to the selected window.

1.4.3.c Owner shall review and approve work prior to start of other work.

1.4.3.d Approved work shall be used as standard of acceptance for other work.

Note: If repair test is not successful, replacement (in kind) of existing windows may be necessary.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Original Packaging. Deliver all materials in original packages, containers, or bundles bearing brand name and identification of manufacturer.

1.5.2 Storage. Store all materials inside, under cover, and in manner to keep them dry, protected from weather, direct sunlight, surface contamination, aging, corrosion, and damage from construction traffic and other causes.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Ventilation. Provide adequate ventilation during times of epoxy consolidation and filling. Smoking shall not be permitted during this process.

2 PRODUCTS

2.1 MATERIALS

Note: Brand names of products are stated for reference only and are not intended to limit choice to any particular manufacturer.

2.1.1 Sash Lock. Provide one sash lock, secured at meeting rail. [Ives #07 signal lock] or approved equal, cast iron or bronze.

2.1.2 Sash Lifts. Provide a pair of handles at lower rail or meeting rail, one handle if less than 2'-0" wide. [Ives #026] or approved equal cast iron or bronze.

2.1.3 Weatherstrip. Compression or interlocking weatherstripping, concealed. [Pemko spring bronze #70-100 1-1/2"] fastened with bronze or stainless steel nails at 1-1/2" o.c., or approved equal.

2.1.4 Sash Balances. Replace missing weights and sash cords. Replace all sash cords with new cotton-polypropylene cord rated for sash weight.

2.1.5 Parting Bead. Clear vertical grain Douglas fir, preservative dipped ends. Hem-fir not acceptable.

2.1.6 Ventilating Bolt. Provide one pair for each window sill less than 7'-0" above grade or if adjacent roof or sill height is less than 24" above floor. [Ives #83] or approved equal.

2.1.7 Hardware Finish. US10B oil-rubbed bronze unless noted otherwise.

2.1.8 Replacement Wood for Sash, Frames, Mullions, Trim. Clear vertical grain premium grade Douglas fir, solid stock (finger-jointed fir or hemlock acceptable for interior casing and trim only where schedule for paint).

2.1.9 Patching Compounds. "Liquid Wood" penetrating wood consolidant, and "Wood Epoxy" epoxy structural putty and filler, manufactured by Abatron, Inc., or approved equal. Mix epoxy according to manufacturer's instructions.

2.2 EQUIPMENT

2.2.1 Sand paper. Coarse grit, open-coat flint sand paper shall be used for hand sanding on paint.

2.2.2 Orbital and Belt Sanders. Medium grit, open-coat aluminum oxide sandpaper shall be used with orbital and belt sanders.

2.2.3 Heat Guns. Heat guns shall be operated at temperatures less than 750 degrees F (lead paint will vaporize at higher temperatures).

2.2.4 Chemical Strippers. Chemical strippers must not contain methylene chloride.

3 EXECUTION

3.1 PREPARATION

3.1.1 Sash Removal. Remove all upper and lower sashes. Repair and reinforce all loose corners with weather resistant screws or other appropriate fastening devices. Replace all sash cords. Provide protection from weather while sashes are being repaired.

3.1.2 Paint Preparation. Remove paint to first sound paint layer. Clean surfaces. Degloss all existing finish and caulk all joint, cracks and perimeter to fixed sash.

3.2 INSTALLATION

3.2.1 Repair or replace all wood sash, frame, and trim assemblies to provide proper operation and sound condition of all renovated windows.

3.2.2 Remove areas more than 60% decayed from wood sash, frame, and trim assemblies.

3.2.3 Patch areas less than 60% decayed or weathered or gouged wood with approved patching compounds, and sand smooth.

3.2.4 Repair loose or fallen rails with new dowels glued in place.

3.2.5 Where pieces are decayed beyond repair, replace with new pieces matching original profile.

3.2.6 Muntins. Repair damaged or decayed areas so that muntins match closely to original profile.

3.2.7 Paint. Paint all wood parts of window except in places were members slide past each other. Paint underside of lower sash. Do not paint hardware or sash cords.

3.2.8 Glazing. Replace all broken glass with like kind. Replace all loose and deteriorated glazing putty.

3.2.9 Hardware. Reuse all existing hardware which is in good working condition except as specified. Install new hardware and weatherstripping as specified where original hardware is missing, damaged, or unsuitable for new operation, per manufacturer's directions to provide a complete, secure, weather-tight and smoothly operating window assembly. Strip existing hardware down to bare metal.

3.2.10 Parting Beads. Replace all parting beads with new wood parting beads.

3.2.11 Trim. Retain interior trim and replace any damage same using sound matching salvaged material.

3.3 CLEAN-UP

3.3.1 Adjustments. Adjust operating sash and hardware to provide smooth operation with tight, weatherproof closure. Lubricate hardware and moving parts.

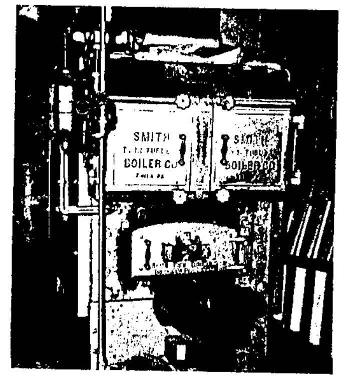
3.3.2 Clean glass and window units after installation.

3.3.3 Upon completion of repair, clean all affected surfaces, leaving area as it was before construction began.

END OF SECTION

Appendix D: *Preservation Briefs 24*

24 PRESERVATION BRIEFS



Heating, Ventilating, and Cooling Historic Buildings: Problems and Recommended Approaches

Sharon C. Park, AIA

U.S. Department of the Interior
National Park Service
Cultural Resources
Preservation Assistance

The need for modern mechanical systems is one of the most common reasons to undertake work on historic buildings. Such work includes upgrading older mechanical systems, improving the energy efficiency of existing buildings, installing new heating, ventilation or air conditioning (HVAC) systems, or—particularly for museums—installing a climate control system with humidification and dehumidification capabilities. Decisions to install new HVAC or climate control systems often result from concern for occupant health and comfort, the desire to make older buildings marketable, or the need to provide specialized environments for operating computers, storing artifacts, or displaying museum collections. Unfortunately, occupant comfort and concerns for the objects within the building are sometimes given greater consideration than the building itself. In too many cases, applying modern standards of interior climate comfort to historic buildings has proven detrimental to historic materials and decorative finishes.

This Preservation Brief underscores the importance of careful planning in order to balance the preservation objectives with interior climate needs of the building. It is not intended as a technical guide to calculate tonnage or to size piping or ductwork. Rather, this Brief identifies some of the problems associated with installing mechanical systems in historic buildings and recommends approaches to minimizing the physical and visual damage associated with installing and maintaining these new or upgraded systems.

Historic buildings are not easily adapted to house modern precision mechanical systems. Careful planning must be provided early on to ensure that decisions made during the design and installation phases of a new system are appropriate. Since new mechanical and other related systems, such as electrical and fire suppression, can use up to 10% of a building's square footage and 30%–40% of an overall rehabilitation budget, decisions must be made in a systematic and coordinated manner. The installation of inappropriate mechanical systems may result in any or all of the following:

- large sections of historic materials are removed to install or house new systems.
- historic structural systems are weakened by carrying the weight of, and sustaining vibrations from, large equipment.
- moisture introduced into the building as part of a new system migrates into historic materials and causes damage, including biodegradation, freeze/thaw action, and surface staining.
- exterior cladding or interior finishes are stripped to install new vapor barriers and insulation.
- historic finishes, features, and spaces are altered by dropped ceilings and boxed chases or by poorly located grilles, registers, and equipment.
- systems that are too large or too small are installed before there is a clearly planned use or a new tenant.

For historic properties it is critical to understand what spaces, features, and finishes are historic in the building, what should be retained, and what the *realistic* heating, ventilating, and cooling needs are for the building, its occupants, and its contents. A systematic approach, involving preservation planning, preservation design, and a follow-up program of monitoring and maintenance, can ensure that new systems are successfully added—or existing systems are suitably upgraded—while preserving the historic integrity of the building.

No set formula exists for determining what type of mechanical system is best for a specific building. Each building and its needs must be evaluated separately. Some buildings will be so significant that every effort must be made to protect the historic materials and systems in place with minimal intrusion from new systems. Some buildings will have museum collections that need special climate control. In such cases, curatorial needs must be considered—but not to the ultimate detriment of the historic building resource. Other buildings will be rehabilitated for commercial use. For them, a variety of systems might be acceptable, as long as significant spaces, features, and finishes are retained.

Most mechanical systems require upgrading or replacement within 15-30 years due to wear and tear or the availability of improved technology. Therefore, historic buildings should not be greatly altered or otherwise sacrificed in an effort to meet short-term systems objectives.

History of Mechanical Systems

The history of mechanical systems in buildings involves a study of inventions and ingenuity as building owners, architects, and engineers devised ways to improve the interior climate of their buildings. Following are highlights in the evolution of heating, ventilating, and cooling systems in historic buildings.

Eighteenth Century. Early heating and ventilation in America relied upon common sense methods of *managing the environment* (see figure 1). Builders purposely sited houses to capture winter sun and prevailing summer cross breezes; they chose materials that could help protect the inhabitants from the elements, and took precautions against precipitation and damaging drainage patterns. The location and sizes of windows, doors, porches, and the floor plan itself often evolved to maximize ventilation. Heating was primarily from fireplaces or stoves and, therefore, was at the source of delivery. In 1744, Benjamin Franklin designed his "Pennsylvania stove" with a fresh air intake in order to maximize the heat radiated into the room and to minimize annoying smoke.

Thermal insulation was rudimentary—often wattle and daub, brick and wood nogging. The comfort level for occupants was low, but the relatively small difference between internal and external temperatures and relative humidity allowed building materials to expand and contract with the seasons.

Regional styles and architectural features reflected regional climates. In warm, dry and sunny climates, thick adobe walls offered shelter from the sun and kept the inside temperatures cool. Verandas, courtyards, porches, and high ceilings also reduced the impact of the sun. Hot and humid climates called for elevated living floors, louvered grilles and shutters, balconies, and interior courtyards to help circulate air.

Nineteenth Century. The industrial revolution provided the technological means for *controlling the environment* for the first time (see figure 2). The dual developments of steam energy from coal and industrial mass production made possible early central heating systems with distribution of heated air or steam using metal ducts or pipes. Improvements were made to early wrought iron boilers and by late century, steam and low pressure hot water radiator systems were in common use, both in offices and residences. Some large institutional buildings heated air in furnaces and distributed it throughout the building in brick flues with a network of metal pipes delivering heated air to individual rooms. Residential designs of the period often used gravity hot air systems utilizing decorative floor and ceiling grilles.

Ventilation became more scientific and the introduc-

1. Eighteenth century and later vernacular architecture depended on the siting of the building, deciduous trees, cross ventilation, and the placement of windows and chimneys to maximize winter heating and natural summer cooling. Regional details, as seen in this Virginia house, include external chimneys and a separate summer kitchen to reduce fire risk and isolate heat in the summer. Photo: NPS Files.

2. Nineteenth century buildings continued to use architectural features such as porches, cupolas, and awnings to make the buildings more comfortable in summer, but heating was greatly improved by hot water or steam radiators. Photo: NPS Files tion of fresh air into buildings became an important component of heating and cooling. Improved forced air ventilation became possible in mid-century with the introduction of power-driven fans. Architectural features such as porches, awnings, window and door transoms, large open-work iron roof trusses, roof monitors, cupolas, skylights and clerestory windows helped to dissipate heat and provide healthy ventilation.

Cavity wall construction, popular in masonry structures, improved the insulating qualities of a building and also provided a natural cavity for the dissipation of moisture produced on the interior of the building. In some buildings, cinder chips and broken masonry filler between structural iron beams and jack arch floor vaults provided thermal insulation as well as fireproofing. Mineral wool and cork were new sources of lightweight insulation and were forerunners of contemporary batt and blanket insulation.

The technology of the age, however, was not sufficient to produce "tight" buildings. There was still only a moderate difference between internal and external temperatures. This was due, in part, to the limitations of early insulation, the almost exclusive use of single glazed windows, and the absence of air-tight construction. The presence of ventilating fans and the reliance on architectural features, such as operable windows, cupolas and transoms, allowed sufficient air movement to keep buildings well ventilated. Building materials could behave in a fairly traditional way, expanding and contracting with the seasons.

Twentieth Century. The twentieth century saw intensive development of new technologies and the notion of fully *integrating mechanical systems* (see figure 3). Oil and gas furnaces developed in the nineteenth century were improved and made more efficient, with electricity becoming the critical source of power for building systems in the latter half of the century. Forced air heating systems with ducts and registers became popular for all types of buildings and allowed architects to experiment with architectural forms free from mechanical encumbrances. In the 1920s large-scale theaters and auditoriums introduced central air conditioning, and by mid-century forced air systems which combined heating and air conditioning in the same ductwork set a new standard for comfort and convenience. The combination and coordination of a variety of systems came together in the post-World War II highrise buildings; complex heating and air conditioning plants, electric elevators, mechanical towers, ventilation fans, and full service electric lighting were integrated into the building's design.

The insulating qualities of building materials improved. Synthetic materials, such as spun fiberglass batt insulation, were fully developed by mid-century. Prototypes of insulated thermal glazing and integral storm window systems were promoted in construction journals. Caulking to seal out perimeter air around window and door openings became a standard construction detail.

The last quarter of the twentieth century has seen making HVAC systems more energy efficient and better integrated. The use of vapor barriers to control moisture migration, thermally efficient windows, caulking and gaskets, compressed thin wall insulation, has become standard practice. New integrated systems now combine interior climate control with fire suppression, lighting, air filtration, temperature and humidity control, and security detection. Computers regulate the performance of these integrated systems based on the time of day, day of the week, occupancy, and outside ambient temperature.

3. The circa 1928 Fox Theater in Detroit, designed by C. Howard Crane, was one of the earliest twentieth century buildings to provide air conditioning to its patrons. The early water-cooled system was recently restored. Commercial and highrise buildings of the twentieth century were able, mostly through electrical power, to provide sophisticated systems that integrated many building services. Photo: William Kessler and Associates, Architects.

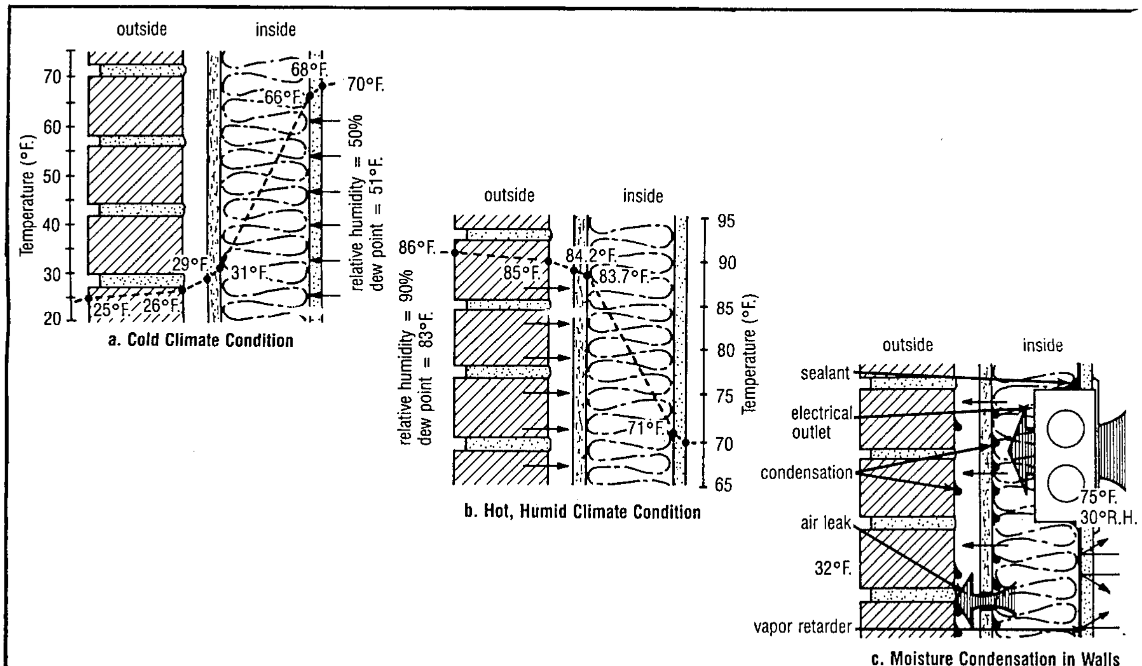
Climate Control and Preservation

Although twentieth century mechanical systems technology has had a tremendous impact on making historic buildings comfortable, the introduction of these new systems in older buildings is not without problems. The attempt to meet and maintain modern climate control standards *may in fact be damaging to historic resources*. Modern systems are often over-designed to compensate for inherent inefficiencies of some historic buildings materials and plan layouts. Energy retrofit measures, such as installing exterior wall insulation and vapor barriers or the sealing of operable window and vents, ultimately affect the performance and can reduce the life of aging historic materials.

In general, the greater the differential between the interior and exterior temperature and humidity levels, the greater the potential for damage. As natural vapor pressure moves moisture from a warm area to a colder, dryer area, condensation will occur on or in building materials in the colder area (see figure 4). Too little humidity in winter, for example, can dry and crack historic wooden or painted surfaces. Too much humidity in winter causes moisture to collect on cold surfaces, such as windows, or to migrate into walls. As a result, this condensation deteriorates wooden or metal windows and causes rotting of walls and wooden structural elements, dampening insulation and holding moisture against exterior surfaces. Moisture migration through walls can cause the corrosion of metal anchors, angles, nails or wire lath, can blister and peel exterior paint, or can leave efflorescence and salt deposits on exterior masonry. In cold climates, freeze-thaw damage can result from excessive moisture in external walls.

To avoid these types of damage to a historic building, it is important to understand how building components work together as a system. Methods for controlling interior temperature and humidity and improving ventilation must be considered in any new or upgraded HVAC or climate control system. While certain energy retrofit measures will have a positive effect on the overall building, installing effective vapor barriers in historic walls is difficult and often results in destruction of significant historic materials (see figure 5).

5. The installation of vapor retarders in walls of historic buildings in an effort to contain interior moisture can cause serious damage to historic finishes as shown here. In this example, all the wall plaster and lath have been stripped in preparation for a vapor barrier prior to replastering. Controlling interior temperature and relative humidity can be more effective than adding insulation and vapor barriers to historic perimeter walls. Photo: Ernest A. Conrad, P.E.



4. Mechanical heating and cooling systems change the interior climate of a building. Moisture in the air will dissipate from the warmer area of a building to the colder area and can cause serious deterioration of historic materials. Condensation can form if the dew point occurs within the building wall, particularly one that has been insulated (see a and b). Even when vapor retarders are installed (c), any non-continuous areas will provide spaces for moisture to pass. Wall Section Drawings: NPS files

Planning the New System

Climate control systems are generally classified according to the medium used to condition the temperature: air, water, or a combination of both (see overview on page 6). The complexity of choices facing a building owner or manager means that a *systematic approach* is critical in determining the most suitable system for a building, its contents, and its occupants. No matter which system is installed, a change in the interior climate will result. This physical change will in turn affect how the building materials perform. New registers, grilles, cabinets, or other accessories associated with the new mechanical system will also visually change the interior (and sometimes the exterior) appearance of the building. Regardless of the type or extent of a mechanical system, the owner of a historic building should know *before* a system is installed what it will look like and what problems can be anticipated during the life of that system. The potential harm to a building and costs to an owner of selecting the wrong mechanical system are very great.

The use of a building and its contents will largely determine the best type of mechanical system. The historic building materials and construction technology as well as the size and availability of secondary spaces within the historic structure will affect the choice of a system. It may be necessary to investigate a combination of systems. In each case, the needs of the user, the needs of the building, and the needs of a collection or equipment must be considered. It may not be necessary to have a comprehensive climate control system if climate-sensitive objects can be accommodated in special areas or climate-controlled display cases. It may not be necessary to have central air conditioning in a mild climate if natural ventilation systems can be improved through the use of operable windows, awnings, exhaust fans, and other "low-tech" means. Modern standards for climate control developed for new construction may not be achievable or desirable for historic buildings. *In each case, the lowest level of intervention needed to successfully accomplish the job should be selected.*

Before a system is chosen, the following planning steps are recommended:

1. **Determine the use of the building.** The proposed use of the building (museum, commercial, residential, retail) will influence the type of system that should be installed. The number of people and functions to be housed in a building will establish the level of comfort and service that must be provided. Avoid uses that require major modifications to significant architectural spaces. What is the intensity of use of the building: intermittent or constant use, special events or seasonal events? Will the use of the building require major new services such as restaurants, laundries, kitchens, locker rooms, or other areas that generate moisture that may exacerbate climate control within the historic space? In the context of historic preservation, uses that require radical reconfigurations of historic spaces are inappropriate for the building.

2. **Assemble a qualified team.** This team ideally should consist of a preservation architect, mechanical engineer, electrical engineer, structural engineer, and preservation consultants, each knowledgeable in codes and local requirements. If a special use (church, museum, art studio) or a collection is involved, a specialist familiar with the mechanical requirements of that building type or collection should also be hired.

Team members should be familiar with the needs of historic buildings and be able to balance complex factors: the preservation of the historic architecture (aesthetics and conservation), requirements imposed by mechanical systems (quantified heating and cooling loads), building codes (health and safety), tenant requirements (quality of comfort, ease of operation), access (maintenance and future replacement), and the overall cost to the owner.

3. **Undertake a condition assessment of the existing building and its systems.** What are the existing construction materials and mechanical systems? What condition are they in and are they reusable (see figure 6)? Where are existing chillers, boilers, air handlers, or cooling towers located? Look at the condition of all other services that may benefit from being integrated into a new system, such as electrical and fire suppression systems. Where can energy efficiency be improved to help downsize any new equipment added, and which of the historic features, e.g. shutters, awnings, skylights, can be reused (see figure 7)? Evaluate air infiltration through the exterior envelope; monitor the interior for temperature and humidity levels with hygrothermographs for at least a year. Identify building, site, or equipment deficiencies or the presence of asbestos that must be corrected prior to the installation or upgrading of mechanical systems.

6. A condition assessment during the planning stage would identify this round radiator in a small oval-shaped vestibule as a significant element of the historic heating system. In upgrading the mechanical system, the radiator should be retained. Photo: Michael C. Henry, P.E., AIA.

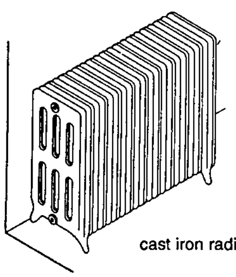
Overview of HVAC Systems

WATER SYSTEMS: Hydronic radiators, Fan coil, or radiant pipes

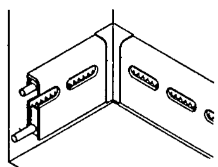
Water systems are generally called *hydronic* and use a network of pipes to deliver water to hot water radiators, radiant pipes set in floors or fan coil cabinets which can give both heating and cooling. Boilers produce hot water or steam; chillers produce chilled water for use with fan coil units. Thermostats control the temperature by zone for radiators and radiant floors. Fan coil units have individual controls. Radiant floors provide quiet, even heat, but are not common.

Advantages: Piped systems are generally easier to install in historic buildings because the pipes are smaller than ductwork. **Disadvantages:** There is the risk, however, of hidden leaks in the wall or burst pipes in winter if boilers fail. Fan coil condensate pans can overflow if not properly maintained. Fan coils may be noisy.

Hydronic Radiators: Radiators or baseboard radiators are looped together and are usually set under windows or along perimeter walls. New boilers and circulating pumps can upgrade older systems. Most piping was cast iron although copper systems can be used if separately zoned. Modern cast iron baseboards and copper fin-tubes are available. Historic radiators can be reconditioned.

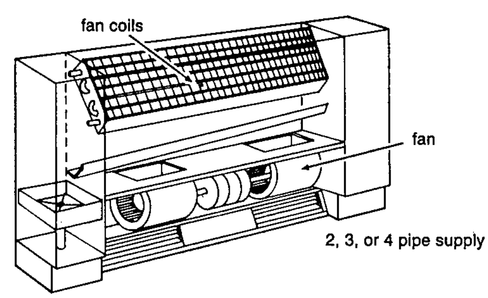


cast iron radiator



cast iron baseboard

Fan Coil Units: Fan coil systems use terminal cabinets in each room serviced by 2, 3, or 4 pipes approximately 1-1/2" each in diameter. A fan blows air over the coils which are serviced by hot or chilled water. Each fan coil cabinet can be individually controlled. Four-pipe fan coils can provide both heating and cooling all year long. Most piping is steel. Non-cabinet units may be concealed in closets or custom cabinetry, such as benches, can be built.



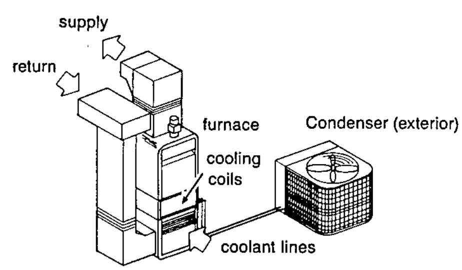
Fan coil unit

CENTRAL AIR SYSTEMS

The basic heating, ventilation and air conditioning (HVAC) system is all-air, single zone fan driven designed for low, medium or high pressure distribution. The system is composed of compressor drives, chillers, condensers, and furnace depending on whether the air is heated, chilled or both. Condensers, generally air cooled, are located outside. The ducts are sheet metal or flexible plastic and can be insulated. Fresh air can be circulated. Registers can be designed for ceilings, floors and walls. The system is controlled by thermostats; one per zone.

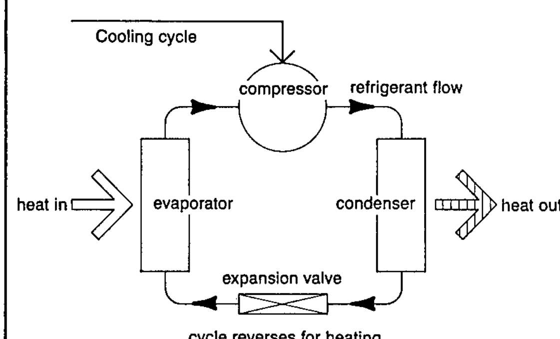
Advantages: Ducted systems offer a high level of control of interior temperature, humidity, and filtration. Zoned units can be relatively small and well concealed.
Disadvantages: The damage from installing a ducted system without adequate space can be serious for a historic building. Systems need constant balancing and can be noisy.

Basic HVAC: Most residential or small commercial systems will consist of a basic furnace with a cooling coil set in the unit and a refrigerant compressor or condenser located outside the building. Heating and cooling ductwork is usually shared. If sophisticated humidification and dehumidification is added to the basic HVAC system, a full climate control system results. This can often double the size of the equipment.



Heating furnace with cooling coil

Basic Heat Pump/Air System: The heat pump is a basic HVAC system as described above except for the method of generating hot and cold air. The system operates on the basic refrigeration cycle where latent heat is extracted from the ambient air and is used to evaporate refrigerant vapor under pressure. Functions of the condenser and evaporator switch when heating is needed. Heat pumps, somewhat less efficient in cold climates, can be fitted with electric resistance coil.



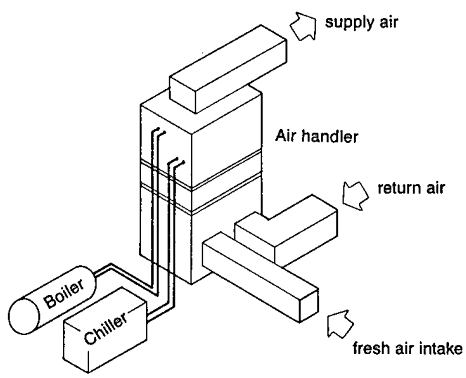
COMBINED AIR AND WATER SYSTEMS

These systems are popular for restoration work because they combine the ease of installation for the piped system with the performance and control of the ducted system. Smaller air handling units, not unlike fan coils, may be located throughout a building with service from a central boiler and chiller. In many cases the water is delivered from a central plant which services a complex of buildings.

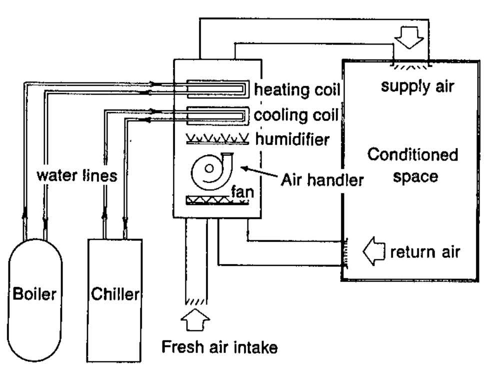
This system overcomes the disadvantages of a central ducted system where there is not adequate horizontal or vertical runs for the ductwork. The equipment, being smaller, may also be quieter and cause less vibration. If only one air handler is being utilized for the building, it is possible to house all the equipment in a vault outside the building and send only conditioned air into the structure.

Advantages: flexibility for installation using greater piping runs with shorter ducted runs; Air handlers can fit into small spaces.
Disadvantages: piping areas may have undetected leaks; air handlers may be noisy.

Water-serviced Air Handlers:



Typical Systems Layout:



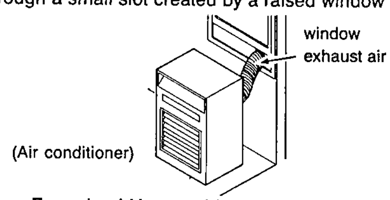
OTHER SYSTEM COMPONENTS

Non-systems components should not be overlooked if they can make a building more comfortable without causing damage to the historic resource or its collection.

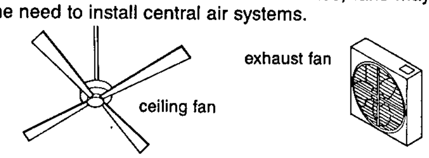
Advantages: components may provide acceptable levels of comfort without the need for an entire system.
Disadvantages: Spot heating, cooling and fluxuations in humidity may harm sensitive collections or furnishings. If an integrated system is desirable, components may provide only a temporary solution.

Portable Air Conditioning:

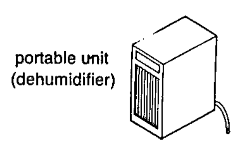
Most individual air conditioners are set in windows or through exterior walls which can be visually as well as physically damaging to historic buildings. Newer portable air conditioners are available which sit in a room and exhaust directly to the exterior through a small slot created by a raised window sash.



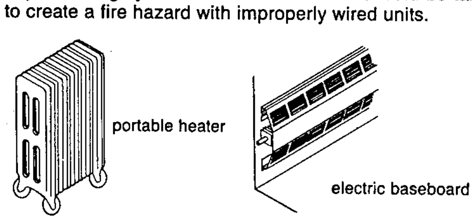
Fans: Fans should be considered in most properties to improve ventilation. Fans can be located in attics, at the top of stairs, or in individual rooms. In moderate climates, fans may eliminate the need to install central air systems.



Dehumidifiers: For houses without central air handling systems, a dehumidifier can resolve problems in humid climates. Seasonal use of dehumidifiers can remove moisture from damp basements and reduce fungal growth.



Heaters: Portable radiant heaters, such as those with water and glycol, may provide temporary heat in buildings used infrequently or during systems breakdowns. Care should be taken not to create a fire hazard with improperly wired units.

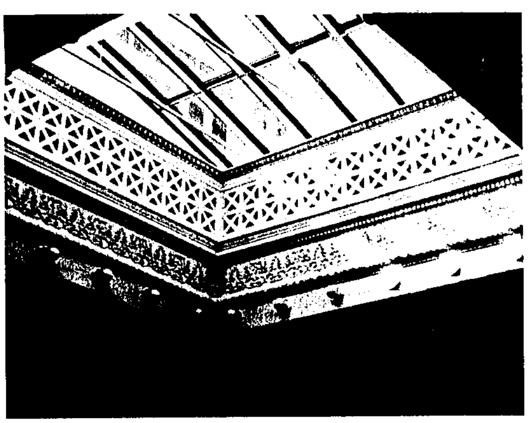


Compiled by Sharon C. Park. Sketches adapted from *Architectural Graphic Standards* with permission from John Wiley and Sons.

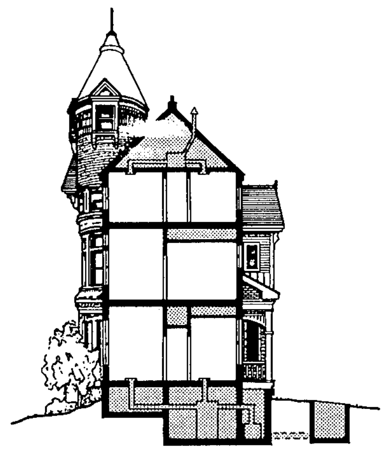
4. **Prioritize architecturally significant spaces, finishes, and features to be preserved.** Significant architectural spaces, finishes and features should be identified and evaluated at the outset to ensure their preservation. This includes significant existing mechanical systems or elements such as hot water radiators, decorative grilles, elaborate switchplates, and non-mechanical architectural features such as cupolas, transoms, or porches. Identify non-significant spaces where mechanical equipment can be placed and secondary spaces where equipment and distribution runs on both a horizontal and vertical basis can be located. Appropriate secondary spaces for housing equipment might include attics, basements, penthouses, mezzanines, false ceiling or floor cavities, vertical chases, stair towers, closets, or exterior below-grade vaults (see figure 8).

5. **Become familiar with local building and fire codes.** Owners or their representatives should meet early and often with local officials. Legal requirements should be checked; for example, can existing ductwork be reused or modified with dampers? Is asbestos abatement required? What are the energy, fire, and safety codes and standards in place, and how can they be met while maintaining the historic character of the building? How are fire separation walls and rated mechanical systems to be handled between multiple tenants? Is there a requirement for fresh air intake for stair towers that will affect the exterior appearance of the building? Many of the health, energy, and safety code requirements will influence decisions made for mechanical equipment for climate control. It is importance to know what they are before the design phase begins.

6. **Evaluate options for the type and size of systems.** A matrix or feasibility studies should be developed to balance the benefits and drawbacks of various systems. Factors to consider include heating and/or cooling, fuel type, distribution system, control devices, generating equipment and accessories such as filtration, and humidification. What are the initial installation costs, projected fuel costs, long-term maintenance, and life-cycle costs of these components and systems? Are parts of an existing system being reused and upgraded? The benefits of added ventilation should not be overlooked (see figure 9). What are the trade-offs between one large central system and multiple smaller systems? Should there be a forced air ducted system, a 2-pipe fan coil system, or a combined water and air system? What space is available for the equipment and distribution system? Assess the fire-risk levels of various fuels. Understand the advantages and disadvantages of the various types of mechanical systems available. *Then evaluate each of these systems in light of the preservation objectives established during the design phase of planning.*



7. Operable skylights and grilles that can be adapted for return air should be identified as part of the planning phase for new or upgraded mechanical systems. Photo: Dianne Pierce, NPS files.



8. In considering options for new systems, existing spaces should be evaluated for their ability to house new equipment. This sketch shows several areas where new mechanical equipment could be located to avoid damaging significant spaces. Sketch: NPS files

9. Improving ventilation through traditional means should not be overlooked in planning new or upgraded HVAC systems. In mild climates, good exhaust fans can often eliminate the need for air conditioning or can reduce equipment size by reducing cooling loads. Photo: Ernest A. Conrad, P.E.

Designing the new system

In designing a system, it is important to anticipate how will be installed, how damage to historic materials can be minimized, and how visible the new mechanical system will be within the restored or rehabilitated spaces (see figure 10 a–f). Mechanical equipment space needs are often overwhelming; in some cases, it may be advantageous to look for locations outside of the building, including ground vaults, to house some of the equipment but only if it there is no adverse impact to the historic landscape or adjacent archeological resources. Various means for reducing the heating and cooling loads (and thereby the size of the equipment) should be investigated. This might mean reducing slightly the comfort levels of the interior, increasing the number of climate control zones, or improving the energy efficiency of the building.

The following activities are suggested during the design phase of the new system:

1. Establish specific criteria for the new or upgraded mechanical system. New systems should be *installed with a minimum of damage* to the resource and should be visually *compatible with the architecture* of the building. They should be installed in a way that is *easy to service,* maintain, and upgrade in the future. There should be *safety and back-up monitors in place* if buildings have collections, computer rooms, storage vaults or special conditions that need monitoring. The new *systems should work within the structural limits* of the historic building. They should produce *no undue vibration, no undue noise, no dust or mold,* and *no excess moisture* that could damage the historic building materials. If any equipment is to be located outside of the building, there should be *no impact to the historic appearance of building or site,* and there should be *no impact on archeological resources.*

2. Prioritize the requirements for the new climate control system. The use of the building will determine the level of interior comfort and climate control. Sometimes, various temperature zones may safely be created within a historic building. This zoned approach may be appropriate for buildings with specialized collections storage, for buildings with mixed uses, or for large buildings with different external exposures, occupancy patterns, and delivery schedules for controlled air. Special archives, storage vaults or computer rooms may need a completely different climate control from the rest of the building. Determine temperature and humidity levels for occupants and collections and ventilation requirements between differing zones. Establish if the system is to run 24 hours a day or only during operating or business hours. Determine what controls are optimum (manual, computer, preset automatic, or other). The size and location of the equipment to handle these different situations will ultimately affect the design of the overall system as well.

3. Minimize the impact of the new HVAC on the existing architecture. Design criteria for the new system should be based on the type of architecture of the historic resource. Consideration should be given as to whether or not the delivery system is visible or hidden. Utilitarian and industrial spaces may be capable of accepting a more visible and functional system. More formal, ornate spaces which may be part of an interpretive program may require a less visible or disguised system. A ducted system should be installed without ripping into or boxing out large sections of floors, walls, or ceilings. A wet pipe system should be installed so that hidden leaks will not damage important decorative finishes. In each case, not only the type of system (air, water, combination), but its distribution (duct, pipe) and delivery appearance (grilles, cabinets, or registers) must be evaluated. It may be necessary to use a combination of different systems in order to preserve the historic building. Existing chases should be reused whenever possible.

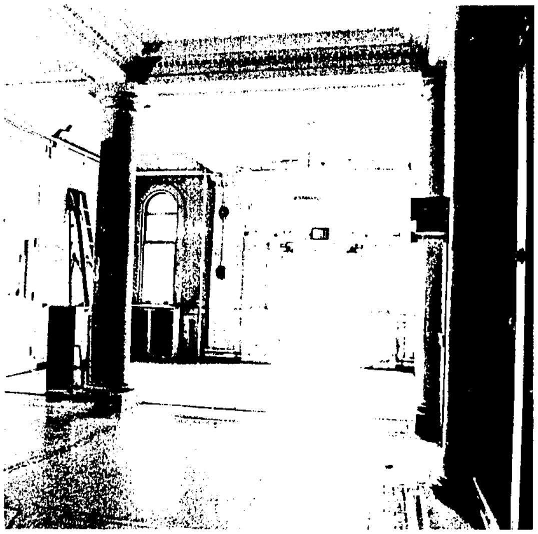
4. Balance quantitative requirements and preservation objectives. The ideal system may not be achievable for each historic resource due to cost, space limitations, code requirements, or other factors beyond the owner's control. However, significant historic spaces, finishes, and features can be preserved in almost every case, even given these limitations. For example, if some ceiling areas must be slightly lowered to accommodate ductwork or piping, these should be in secondary areas away from decorative ceilings or tall windows. If modern fan coil terminal units are to be visible in historic spaces, consideration should be given to custom designing the cabinets or to using smaller units in more locations to diminish their impact. If grilles and registers are to be located in significant spaces, they should be designed to work within the geometry or placement of decorative elements. All new elements, such as ducts, registers, pipe-runs, and mechanical equipment should be installed in a reversible manner to be removed in the future without further damage to the building (see fig 11).

Systems Performance and Maintenance

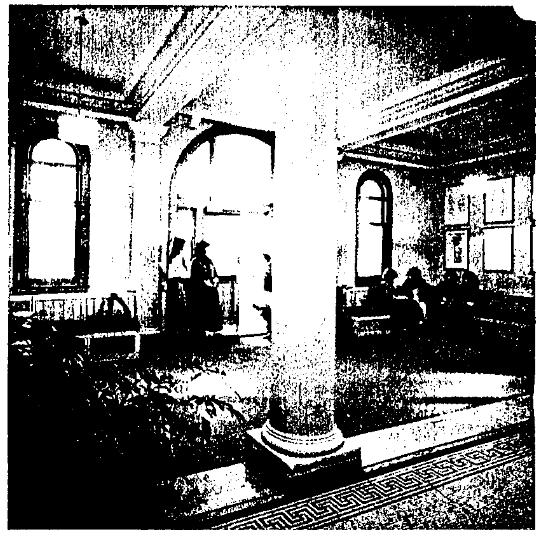
Once the system is installed, it will require routine maintenance and balancing to ensure that the proper performance levels are achieved. In some cases, extremely sophisticated, computerized systems have been developed to control interior climates, but they still need monitoring by trained staff. If collection exhibits and archival storage are important to the resource, the climate control system will require constant monitoring and tuning. Back-up systems are also needed to prevent damage when the main system is not working. The owner, manager, or chief of maintenance should be aware of all aspects of the new climate control system and have a plan of action before it is installed.

Regular training sessions on operating, monitoring, and maintaining the new system should be held for both curatorial and building maintenance staff. If there are curatorial reasons to maintain constant temperature or humidity levels, only individuals thoroughly trained in how the HVAC systems operates should be able to adjust thermostats. Ill-informed and haphazard attempts to adjust comfort levels, or to save energy over weekends and holidays, can cause great damage.

10. The following photographs illustrate recent preservation projects where careful planning and design retained the historic character of the resources.

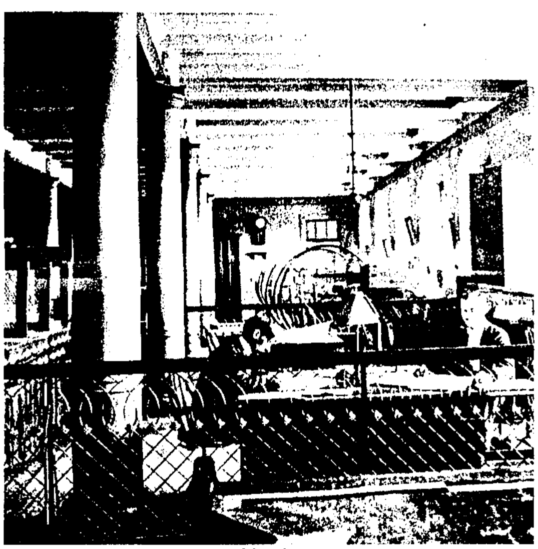


before



after

a. Before and after of a circa 1900 school entrance. The radiators have been replaced with a two-pipe fan coil system built into bench seats. The ceiling was preserved and no exposed elements were required to add air conditioning. Piping runs are under the benches and there was no damage to the masonry walls. Photos: Notter Finegold + Alexander Inc. and Lautman Photography, Washington.



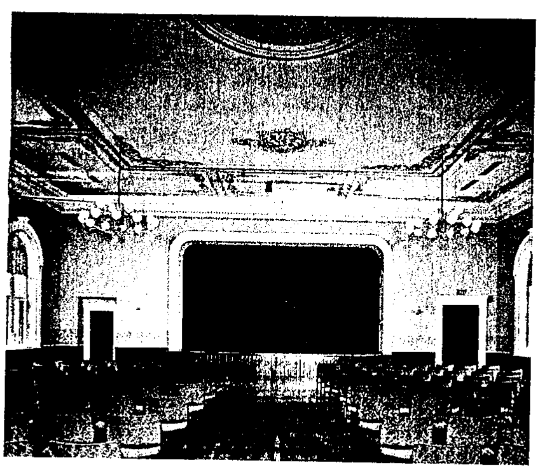
historic

after

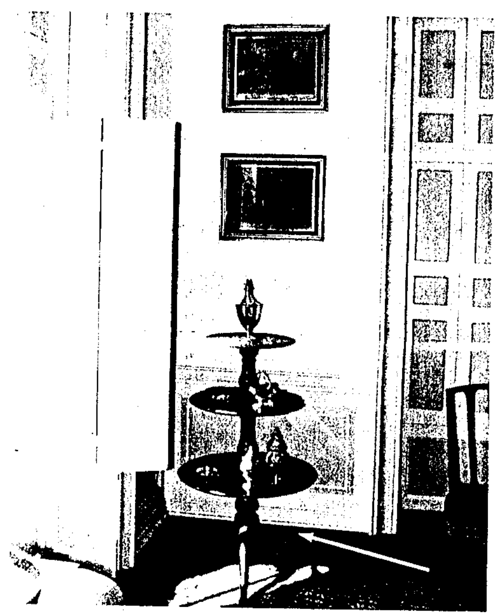
d. Auditors Buildings, Washington, D.C. This upper floor workspace had been modified over the years with dropped ceilings and partitions. In the recent restoration, the open plan workspace was restored, the false ceiling was removed, and the fireproof construction was exposed. A vari able air volume (VAV) system using round double shell exposed ductwork is in keeping with the industrial character of the architectural space. Photo: Kenneth Wyner Photography, courtesy of Notter Finegold + Alexander Inc. Before view provided by Notter Finegold + Alexander/Mariani.

b. *Central air conditioning was installed in the corridors of this circa 1900 school building by adding an air handler over the entrance from a vestibule. ˙˙? custom-designed slot registers provide linear diffusers without detracting ,n the architecture of the space. Photo: Lautman Photography courtesy of Notter Finegold + Alexander Inc.*

c. *Conference room, Auditors Building, Washington, D.C. The historic steam radiators were retained for heating. The cast iron ceiling register was retained as a decorative element, but made inoperable to meet fire codes. Photo: Kenneth Wyner Photography courtesy of Notter Finegold + Alexander Inc.*



e. *Town Hall, Andover, MA. The upstairs auditorium was restored and new ˙˙chanical systems were installed. Perimeter baseboard radiation provides t and air handlers, located in the attic space provide air conditioning. The cast iron ceiling grille was adapted for return air and the supply registers were installed in a symmetrical and regular manner to minimize impact on the historic ceiling. Photo: David Hewitt/Anne Garrison for Ann Beha Associates.*



f. *Homewood, Baltimore, MD. This elegant circa 1806 residence is now a house museum. The registers for the forced air ducted system seen behind the table legs, are grained to blend with the historic baseboards. The HVAC system uses a water/air system where chilled water and steam heat are converted to conditioned air. Photo: Courtesy Homewood Museum, Johns Hopkins University.*

HVAC Do's and Don'ts

DO's:

- Use shutters, operable windows, porches, curtains, awnings, shade trees and other historically appropriate non-mechanical features of historic buildings to reduce the heating and cooling loads. Consider adding sensitively designed storm windows to existing historic windows.
- Retain or upgrade existing mechanical systems whenever possible: for example, reuse radiator systems with new boilers, upgrade ventilation within the building, install proper thermostats or humidistats.
- Improve energy efficiency of existing buildings by installing insulation in attics and basements. Add insulation and vapor barriers to exterior walls *only* when it can be done without further damage to the resource.
- In major spaces, retain decorative elements of the historic system whenever possible. This includes switchplates, grilles and radiators. Be creative in adapting these features to work within the new or upgraded system.
- Use space in existing chases, closets or shafts for new distribution systems.
- Design climate control systems that are compatible with the architecture of the building: hidden system for formal spaces, more exposed systems possible in industrial or secondary spaces. In formal areas, avoid standard commercial registers and use custom slot registers or other less intrusive grilles.
- Size the system to work within the physical constraints of the building. Use multi-zoned smaller units in conjunction with existing vertical shafts, such as stacked closets, or consider locating equipment in vaults underground, if possible.
- Provide adequate ventilation to the mechanical rooms as well as to the entire building. Selectively install air intake grilles in less visible basement, attic, or rear areas.
- Maintain appropriate temperature and humidity levels to meet requirements without accelerating the deterioration of the historic building materials. Set up regular monitoring schedules.
- Design the system for maintenance access and for future systems replacement.
- For highly significant buildings, install safety monitors and backup features, such as double pans, moisture detectors, lined chases, and battery packs to avoid or detect leaks and other damage from system failures.
- Have a regular maintenance program to extend equipment life and to ensure proper performance.
- Train staff to monitor the operation of equipment and to act knowledgeably in emergencies or breakdowns.
- Have an emergency plan for both the building and any curatorial collections in case of serious malfunctions or breakdowns.

DON'TS:

- Don't install a new system if you don't need it.
- Don't switch to a new type of system (e.g. forced air) unless there is sufficient space for the new system or an appropriate place to put it.
- Don't over-design a new system. Don't add air conditioning or climate control if they are not absolutely necessary.
- Don't cut exterior historic building walls to add through-wall heating and air conditioning units. These are visually disfiguring, they destroy historic fabric, and condensation runoff from such units can further damage historic materials.
- Don't damage historic finishes, mask historic features, or alter historic spaces when installing new systems.
- Don't drop ceilings or bulkheads across window openings.
- Don't remove repairable historic windows or replace them with inappropriately designed thermal windows.
- Don't seal operable windows, unless part of a museum where air pollutants and dust are being controlled.
- Don't place condensers, solar panels, chimney stacks, vents or other equipment on visible portions of roofs or at significant locations on the site.
- Don't overload the building structure with the weight of new equipment, particularly in the attic.
- Don't place stress on historic building materials through the vibrations of the new equipment.
- Don't allow condensation on windows or within walls to rot or spall adjacent historic building materials.

Maintenance staff should learn how to operate, monitor, and maintain the mechanical equipment. They must know where the maintenance manuals are kept. Routine maintenance schedules must be developed for changing and cleaning filters, vents, and condensate pans to control fungus, mold, and other organisms that are dangerous to health. Such growths can harm both inhabitants and equipment. (In piped systems, for example, molds in condensate pans can block drainage lines and cause an overflow to leak onto finished surfaces). Maintenance staff should also be able to monitor the appropriate gauges, dials, and thermographs. Staff must be trained to intervene in emergencies, to know where the master controls are, and whom to call in an emergency. As new personnel are hired, they will also require maintenance training.

In addition to regular cyclical maintenance, thorough inspections should be undertaken from time to time to evaluate the continued performance of the climate control system. As the system ages, parts are likely to fail, and signs of trouble may appear. Inadequately ventilated areas may smell musty. Wall surfaces may show staining, wet patches, bubbling or other signs of moisture damage. Routine tests for air quality, humidity, and temperature should indicate if the system is performing properly. If there is damage as a result of the new system, it should be repaired immediately and then closely monitored to ensure complete repair.

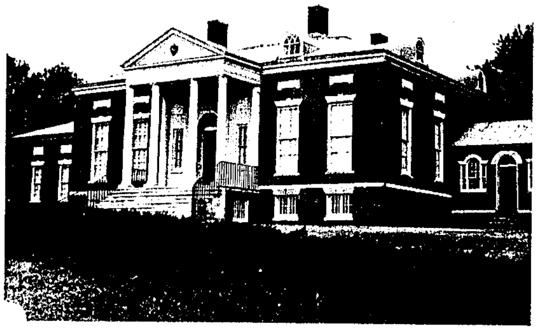
Equipment must be accessible for maintenance and should be visible for easy inspection. Moreover, since mechanical systems last only 15–30 years, the system itself must be "reversible." That is, the system must be installed in such a way that later removal will not damage the building. In addition to servicing, the back-up monitors that signal malfunctioning equipment must be routinely checked, adjusted, and maintained. Checklists should be developed to ensure that all aspects of routine maintenance are completed and that data is reported to the building manager.

Conclusion

The successful integration of new systems in historic buildings can be challenging. Meeting modern HVAC requirements for human comfort or installing controlled climates for museum collections or for the operation of complex computer equipment can result in both visual and physical damage to historic resources. Owners of historic buildings must be aware that the final result will involve balancing multiple needs; no perfect heating, ventilating, and air conditioning system exists. In undertaking changes to historic buildings, it is best to have the advice and input of trained professionals who can:

- assess the condition of the historic building,
- evaluate the significant elements that should be preserved or reused,
- prioritize the preservation objectives,
- understand the impact of new interior climate conditions on historic materials,
- integrate preservation with mechanical and code requirements,
- maximize the advantages of various new or upgraded mechanical systems,
- understand the visual and physical impact of various installations,
- identify maintenance and monitoring requirements for new or upgraded systems, and
- plan for the future removal or replacement of the system.

Too often the presumed climate needs of the occupants or collections can be detrimental to the long-term preservation of the building. With a careful balance between the preservation needs of the building and the interior temperature and humidity needs of the occupants, a successful project can result.



b

11. During the restoration of this 1806 National Historic Landmark (photo a), a new climate control system was installed. The architects removed all the earlier mechanical equipment from the house and installed new equipment in a 30' × 40' concrete vault located underground 150 feet from the house itself (photo b). Only conditioned air is blown into the house reusing much of the circa 1930s ductwork. Photos: Thomas C. Jester.

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Acknowledgements

The author gratefully acknowledges the invaluable assistance of Michael C. Henry, P.E., AIA, in the development and technical editing of this Preservation Brief. Technical review was also prc by Ernest A. Conrad, P.E. Thanks is also given to staff members of the National Park Service Cultural Resources Programs, including Tom Keohan and Catherine Colby, Rocky Mountain Region; Michael Crowe, Western Region; Mark Chavez, Midwest Region; Randall J. Biallas, AIA, Chief, Park Historic Architecture Division, and George A. Thorsen, Historical Architect, Denver Service Center. Special thanks is also given to Michael J. Auer of Technical Preservation Services for his editorial assistance in preparing this paper and Tim Buehner for his assistance with the illustrations.

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Preservation Brief 24 was developed under the editorship of H. Ward Jandl, Chief, Technical Preservation Services. Comments on the usefulness of this publication may be directed to Chief, Technical Preservation Services Branch, Preservation Assistance Division, National Park Service, P.O. Box 37127, Washington, D.C. 20013-7127. This publication is not copyrighted and can be reproduced without pe·· 'ty. Normal procedures for cre·'· the author and the National Park Service are appreciated.

cover photo: This historic coal boiler continues in use after its conversion to an oil-fired boiler. Photo: NPS files

Washington, DC 1991

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